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# ***JPRS Report***

## **Science & Technology**

***CHINA: Energy***

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# Science & Technology

## China: Energy

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### Energy Output Increases in January

40100027A Beijing XINHUA in English 1147 GMT  
2 Feb 90

[Text] Beijing, February 2 (XINHUA)—China's energy output hit the state target in the first month of the 1990s.

Despite the effect of low temperatures on the transport of coal and the Spring Festival holidays in January, China produced 48 billion kilowatt-hours of electricity, an increase of 7 percent compared with the output over the same period last year.

In January China also produced 1.3 billion cubic meters of natural gas, a growth of 10 percent on last January's figure, and 11.75 million tons of oil, an increase of 2 percent.

An official of the Ministry of Energy Resources said it was marvelous to see an increase in energy output in January, which had three fewer working days than last January, as the Spring Festival holidays in 1989 fell in February.

He said coal output reached 65 million tons, equal to a daily output of 2.3 million tons not counting the 3-day holidays. The daily output increased by 6 percent on last January's figure.

One hundred and eighty of the 600 coal mines in China were stopped for inspection and repair in January, and low temperatures seriously affected the production of open-cut coal mines.

To maintain the increase in coal output, the China National Coal Corporation asked miners to work an extra shift during the Spring Festival. They produced 2.29 million tons of coal in the 3 days.

### Largest Power Facilities Listed

40100027B Beijing CEI Database in English  
0830 GMT 5 Feb 90

[Text] Beijing—Following are the largest power facilities of their type:

The largest	Power stations	Capacity
Hydropower	Gezhouba	2.715 m.kW
Thermal power	Jianbi	1.625 m.kW
Nuclear power	Daya Bay	1.8 m.kW
Pumped-storage	Guangzhou	1.2 m.kW
Tidal power	Jiangxia	3,900 kW
Wind power	Chaiwobao	4,000 kW
Geothermal	Yangbajing	13,000 kW

### State Council Approves Construction, Expansion of 27 Energy Projects

40130011b Chengdu SICHUAN RIBAO in Chinese  
23 Nov 89 p 1

[Summary] In order to augment the construction of the energy base, the State Council has approved the new construction and expansion of 27 capital construction projects involving coal and electric power. The projects include the first phase of the Junggar open-pit coal mine project in Nei Monggol, the Fuling and Kaixian power plants in Sichuan, the 500,000 volt transmission project for the Daya Bay nuclear power plant in Guangdong, and the power plants for the Daqing and Shengli oil fields. In order to alleviate the energy crunch, the state is continuing to implement the policy of giving priority to the energy industry; even while the scope of capital construction is being scaled back greatly, 20 billion yuan is still being earmarked for coal and electric power construction projects, 5 billion of which represents foreign capital.

### State Council Okays 49 Coal, Power Construction Projects

40130011a Yinchuan NINGXIA RIBAO in Chinese  
9 Dec 89 p 4

[Summary] Following approval by the State Council, the State Planning Commission has recently ordered the start of 49 medium-to-large coal and electric power capital construction preparatory projects (29 coal/20 power). According to a person with the State Energy Investment Corporation, the investment in these projects represents 45 percent of the country's capital construction preparatory project investment for this year. This demonstrates that the state's policy of giving priority to the energy infrastructure is being implemented. The vast majority of these preparatory projects will start construction next year. After they are all completed, annual coal production capacity will be boosted by 49.24 million tons, with an additional 10.5 million kW of installed power capacity and 330 kilometers of 500,000 volt power transmission lines. Three of the projects use foreign capital for funding, and two of them are energy conservation projects.

### West-to-East Power Transmission Trend Detailed

906B0018B Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 10, 5 Oct 89 pp 34-37

[Article by Wang Zunxiang [3769 1415 4161] of the Southwest Electric Power Administration]

### [Text] I. Development and Present Status of the Power Industry in the Southwest

In the last 40 years since the revolution, the development of the electric power industry in the southwest has provided material basis for the economic development and standard of living improvement in the area. As one

component of the entire industrial system in the southwest, the electric power industry is playing a fundamental and leading role.

The development of electric power in the southwest has amply demonstrated that the speed of electric power development must exceed that of the national economic development. In 1949, shortly after the revolution, the total electric generation capacity in the southwest was only 61,700 kW, the annual output was 205 million kWh, and the total value of industrial and agricultural production was 6.668 billion yuan, out of which 1.083 billion yuan or 16.24 percent was attributed to industry. After the establishment of the new China, there was a 3-year economic recovery period followed by five 5-year plan periods. The electric power industry moved forward rapidly. By 1980, the total generation capacity in the southwest was 7.1361 million kW, which was 115.7 times greater than in 1949 and the average annual rate of growth was 17 percent. The output in 1980 was 26.491 billion kWh, or 129 times of the 1949 output, and the average annual rate of growth was 17.6 percent. The rapid rate of electric power growth promoted the economic growth in the southwest and accelerated the process of industrialization. The industrial and agricultural gross value of production in 1980 was 6.692 billion yuan, which was 10.1 times the 1949 value and the average annual growth was 7.7 percent. Out of the total value of production, 37.07 billion yuan or 55.4 percent was from industry. In this period, other than the electricity shortage experienced by Sichuan during low water season, the electric power in Yunnan and Guizhou was in moderately good shape. Since the Fifth 5-Year Plan period, however, due to various historical reasons, the development of electric power in the southwest has gradually fallen behind the growth of the national economy. In Sichuan the coefficient of elasticity in electric power averaged 2.59 percent in the 26-year period from 1949 to 1975. The electric power satisfied the needs in the national economic development and promoted the rapid progress of Sichuan's industry. By the end of the Fifth 5-Year Plan, the coefficient gradually dropped to 0.83 percent, and then further down to 0.73 percent in the Sixth 5-Year Plan, and severely affected the normal development of the national economy. Although the total generator capacity in the southwest in 1988 had reached 11.309 million kW and the annual output had reached 50.669 billion kWh, the overheated national economy in the southwest caused excessive growth of electrical equipment and home appliances; as a result, even Yunnan and Guizhou suffered from severe power shortage. Yunnan was short 800 million kWh and Guizhou was short 1.8 billion kWh. In Sichuan the ratio of power generation equipment to power consumption equipment quickly rose from 1:2.9 to 1:3.5 and finally to 1:4.1, which was the highest in the nation. More than one-third of Sichuan's production force was rendered inoperative because of the shortage of 1.5 million to 1.7 million kW of power and 7 billion kWh of electric energy. This has caused a loss of 30 billion yuan of production value. From 1980 to 1988 the southwest

power generation equipment increased by 4.1729 million kW at an annual rate of increase of 5.9 percent. This rate was still far less than that in the first 30 years and lagged behind the national economic development. In 1988 the industrial and agricultural gross value of production reached 171.782 billion yuan, higher than the 1980 level by 104.862 billion yuan. The annual rate of growth was 12.5 percent, higher than the rate of growth in electric power and hence causing the severe shortage in electricity.

Another problem is that the energy production structure in the southwest is incompatible with the energy resource structure. The main sources of energy in the southwest are hydropower and coal. The usable water resource is equivalent to 127.8 billion tons of coal (based on 20-year power generation coal consumption); this accounts for 65.37 percent of the total energy reserve. With brown coal converted to standard coal, the coal reserve is 67.7 billion tons or 34.63 percent of the total. This energy composition dictates that development priority should be given to regenerative water resources. The present energy production structure in the southwest, however, is 81 percent in coal and only 11.7 percent in hydropower. In Sichuan natural gas is 7 percent and oil is 0.3 percent. In terms of electric generators, of the 11.309 million kW as of 1988, 54.2 percent were hydropower for primary and secondary energy resources; but this amounted to only 3.48 percent of exploitable water resources. Of the total electric power production of 50.669 billion kWh, 46.6 percent came from hydropower, a mere 2.42 percent of exploitable hydropower. These contradicting energy resource and energy production structures left the advantages of regenerative water resources and hydropower untapped. In the meantime, irreplaceable coal resources were being depleted. In the southwest, 13.15 percent of the coal reserve has been mined, including 7.11 percent of the rich coal reserve in Guizhou, 15.8 percent of the coal in Yunnan, and 42.9 percent of Sichuan's relatively small coal resource. The heavy development of the scarce resources is an enormous waste of the energy resources and will in the long run lead to a vicious cycle of shortages in coal, electric power and transportation.

Looking at the development and present status of electric power in the southwest, it is clear that priority should be given to the energy industry, especially the social development of the electric power industry, and the material basis for the national economic development. The ratio of the rate of electric power development to that of the national economic development (especially industry), i.e., the coefficient of elasticity, must be greater than 1. In the last 40 years, the coefficient in the first 26 years was far greater than 1; the rapid growth of electric power promoted the economic development and industrial construction in the southwest. In the last 10 years or more, the coefficient gradually dropped to below 1; the increasingly severe shortage of electric power became a bottleneck in economic development. Electric power is the principal energy. Primary energy must also

be converted into electric power for convenient consumption. Among the various energy forms, the percentage of electric power consumption will become greater as time goes on. The center of the energy development must be electric power. The energy resources structure in the southwest dictate the following policies for electric power construction: develop hydropower first, reasonably develop thermal electric power, using large power plants as a skeleton to develop large, medium, and small power plants, develop large capacity generators, and build a super high voltage power transmission network. To relieve the immediate shortages at hand, a number of medium-sized hydropower stations should be built quickly.

## II. Strategic Objective: West-to-East Power Transmission

The southwest region of China has a shortage of electric power and coal. The situation in Sichuan is particularly bleak; there is a shortage in both water and coal for electric power generation. Even in Guizhou Province, where there is an abundance of coal, there was a shortage of coal-generated electricity. For many years the nation did not insist on a plan that ensured a coefficient of elasticity greater than 1 in electric power development; as a result, the growth of electric power fell behind that of the national economy. Since the 3d Plenum of the 11th Party Central Committee meeting, the number of electric power generators put into operation each year has been increasing steadily. In 1987 more than 100 million kW of capacity was added to China's power industry and the annual output of electric energy reached 540 billion kWh. Even so, the shortfall accrued over the years and the overheated economy only made the electric power shortage more widespread and severe. The energy crisis has spread to the entire nation and the shortage in coal, electric power and transportation has reached a critical level. Coal and electric power are intimately related; with 70 percent of power generators in China coal-powered, a shortage in coal is a shortage in electric power. In Sichuan and Guizhou, shortage of coal has caused a loss of more than 400,000 kilowatts of electric power. In the future development, coal will still play a major role and a shortage in coal translates into a shortage in electricity. Large and medium hydroelectric power generators built in recent years have always accounted for a small percentage in the hydropower and thermal power capacity. In 1985, 197,500 kW of large and medium hydropower generators were built; this amounted to only 3.6 percent of hydropower and thermal power generators built in that year. In 1986, 853,000 kW of hydropower generators were built, which was 16.6 percent. The year when the largest number of hydropower generators were built was 1987: 2.03 million kW (33.7 percent) of hydropower generators were built. The output came down again in 1988 when 1.535 million kW of hydropower generators were built, accounting for 18.2 percent of the hydro and thermal generators built in 1988. In 1989 the plan called for 988,000 kW of hydroelectric generators and the percentage dropped down to 9.8 percent. This indicated

that hydropower generators that required no coal or transportation have decreased and coal-powered generators increased. This will definitely cause more difficulty in the supply of coal and in transportation.

According to the development goals of the national economy, it was projected that in the year 2000 China would need 1.5 billion tons of standard coal. The development of the primary energy resources in 2000, however, could only provide 1.383 billion tons of standard coal. The make-up of the 1.383 billion tons of standard coal included 1.4 billion tons of raw coal, equivalent to 980 million tons of standard coal; crude oil 200 million tons, equivalent to 280 million tons of standard coal; natural gas 20 billion cubic meters, equivalent to 27 million tons of standard coal; nuclear power 5 million kW at an annual output of 25 billion kWh, equivalent to 8 million tons of standard coal, and 80 million kW of hydropower at an annual output of 250 billion kWh, equivalent to 88 million tons of standard coal. The shortage in the year 2000 (in tons of standard coal) will be 117 million tons. The amount of coal used for power generation in the year 2000, 340 to 370 million tons of standard coal, will be 34.4 to 37.8 percent of the total coal production. If some drastic and decisive policies are not made and implemented, more severe shortages in coal, electricity, and transportation will be unavoidable by the year 2000. Hydropower is the cleanest, most convenient and economic source of energy; it does not rely on coal, transportation and environmental conditions. A major effort must be made to develop the hydropower in the southwest and make this area the base of China's largest, most stable energy center. The development of southwest hydropower will help to balance the primary energy resources in China. In the meantime, an energy center based on thermal electric power should be built in north China so that hydropower and thermal power can assist each other via a network of super high voltage grids. These are the strategic goals and decisions in alleviating the shortages in coal, electricity, and transportation and the increasingly deteriorating environment in the near term and to the year 2000.

Southwestern China has abundant water resources; one-half of China's exploitable hydropower resources are in the southwest. The southwest region has 5 of the 10 hydropower bases planned by the former Ministry of Water Conservancy and Electric Power. These are Jinsha Jiang, Yalong Jiang, Dadu He, Lancang Jiang, and Wu Jiang. At these bases, 98.6 million kW of hydropower generators may be installed (57.6 percent of the capacity at all 10 bases) to produce an annual output of 520.7 billion kWh (91.9 percent of the output of the 10 bases). If one counts Nanpan Jiang and Hongshui He in Guangxi and Guizhou in the southwest region, then the potential capacity will be 64 percent of the 10 bases and the output will be 71 percent. The southwest also has coal reserves of 74.38 billion tons, equal to one-tenth of the national coal reserve. In addition, Sichuan also has natural gas. The southwest region could well become China's largest and most reliable energy center based on

hydropower supplemented by thermal power. In addition to the 500 kV circuit in the southwest, super-high voltage transmission lines may be built to go through Guizhou and Yunnan and join with the south China power grid, and to go through Sichuan and join with the central China power grid. Furthermore, the southwest energy base may send electric power to eastern China by a relay method, that is, the southwest sells electricity to central China so that central China will have electricity to sell to eastern China and thereby achieve the goal of west-to-east power transmission. The southwest may also join with the northwest grid via Sichuan so that the northwest and Sichuan may complement each other. (The northwest has large reservoirs but lacks water, whereas Sichuan has abundant water but small reservoirs.) Preliminary studies showed that the arrangement will not only guarantee an output of 0.68-1.26 million kW and reduce the thermal power capacity required in Sichuan, but also allow the transmission of electricity from the west to the north.

The west-to-east transmission of electricity was dictated by the distribution of hydroelectric and coal resources in China. China has 733.1 billion tons of coal reserves, distributed mainly in northern and northwestern China. These two regions have 72 percent of China's coal reserves. As stated above, China has 378 million kW of viable hydroelectric resources, mainly in the southwest, for an annual output of 1,920 billion kWh. The generator capacity in the southwest is 57.6 of the total and the electricity generated in the southwest is 61.9 percent of the national total. In eastern China, the exploitable hydroelectric resource is only 17.90 million kW (3.6 percent of the national total) and the annual output is 69 billion kWh; the coal reserve in eastern China is only 6 percent of the total. The electric energy consumption in eastern China, on the other hand, is 27-30 percent of the national total. Over the years, coal has been transported from the north to the south in order to generate electricity in eastern China where both coal and hydroelectric resources are scarce. But last year there was not enough coal for generating electricity. According to predictions, the amount of coal needed in eastern China for generating electric power in 2000 and 2015 is respectively 147 million tons and 246 million tons. Even if there were enough coal, transportation and environment are major problems. The critical situation of coal and transportation shortage and environmental deterioration in eastern China can only be alleviated by transmitting electricity from west to east. This is the only solution and the best choice. Guangdong and Guangxi have combined hydroelectric resources of 20.60 million kW (5.45 percent of the national total) and an annual output of 88 billion kWh (4.58 percent of the national total). The two provinces have very little coal, only 3.169 billion tons, or 0.43 percent of China's coal reserves. Nuclear power plant construction has now begun in eastern China and in Guangdong. Nuclear power is needed in regions of energy shortage, but the construction cost for nuclear power is 10 times that of hydropower and the construction time is comparable to that of a medium-size

hydropower plant. Judging from China's present national resources, it is impossible to replace hydropower and thermal power by nuclear power within a short period of time. The national plan of having 5 million kW of nuclear power by the year 2000 and producing 25 billion kWh per year falls far short of solving the coal and electricity shortage problems in eastern and southern China. The best way is to achieve west-to-east power transmission as soon as possible.

### III. Requirements and Problems in West-to-East Power Transmission

West-to-east power transmission is dictated by the distribution of China's resources and cannot be avoided. In the development of the power industry and the construction of energy bases, an unavoidable trend is the linkup of major power grids and river valleys for regulation and compensation. Some of our comrades think that west-to-east power transmission is the way to go, but it is not urgent. I believe that it is not something for the future but imminent. It is now only 11 years before the year 2000 when China must have 80 million kW of hydropower and an annual output of 250 billion kWh. China now has 32.39 million kW of hydropower, which means that in the next 11 years it must add 47.61 million kW of hydropower at an average of 4.14 million kW per year. The relationship between construction capacity and operating capacity is 8 to 1. To achieve an addition of 4.14 million kW per year, the capacity under construction must be maintained at a level of 33.12 million kW at all times. This will not only require construction capital, but also sufficient front-end preparation and available site. In normal preparatory practice, there should be a 4:2:1 ratio, that is, in each year there should be 4.14 million kW of construction design, 8.28 million kW of preliminary design and 16.56 million kW of feasibility study. What is the situation in our current hydropower construction and front-end preparation? According to comrades in the Ministry of Energy, China now has only 16.60 million kW of large and medium hydropower plants under construction; even counting pumping and reserve stations, the total is less than 20 million kW. So a new crisis appeared in the pre-construction preparation work. In the southwest there are many superior hydropower plant sites, but very few of them have reached the readiness for constructing large or medium hydropower stations. In order to realize the west-to-east power transmission and to balance the energy in China, we must take immediate action and delve into a large amount of work. Hydroelectric power is a combination of primary and secondary energy sources and only the development of hydropower will solve the nationwide shortages in electricity, coal and transportation and the deterioration of the environment. In the development of hydropower, the optimum strategic choice is to exploit the superior water resources in the southwest and to achieve west-to-east power transmission. There are five reasons. First, the five rivers in the southwest have abundant water, concentrated drops and fairly constant flow in the high and low water seasons. The topographic

and geological conditions of the major river sections and cascades are superior, the geographic location is central, the reservoir flooding area is not large, the development objective is simple and transportation to the outside is convenient. Second, most of the hydropower sites in the southwest are for the construction of large power stations; a few are for extra large stations. The investments required for the medium, large and extra large stations are in the 1-2 billion yuan, 3-5 billion yuan and 6-7 billion yuan ranges. There are only two power stations that would cost more than 10 billion yuan; these are the Xiangjiaba and Xiluodu stations. These two stations have a combined reservoir capacity of 17.04 billion cubic meters, a generator capacity of 15 million kW, a guaranteed output of 4.51 million kW, and require relocating 85,000 people and flooding 66,000 mu of land. The investment in each power station is not large in such rich water resources consisting of large and medium hydropower stations. Furthermore, since there is a time delay between construction and operation, the state only needs to provide the initial investment and to have a policy that favors the development of river valleys. Once the staged development begins, income from operation will be forthcoming and the investment will not be tied down for very long. Third, the west-to-east power transmission has already begun. Led by the Ministry of Energy and supported by the National Energy Resources Investment Company, the four provinces of Guangdong, Guangxi, Yunnan, and Guizhou cooperated in 1988 in the development of the middle and lower reaches of the Lancang Jiang, Wu Jiang, and Nanpan Jiang. To complement hydropower development, there should also be a cooperative to build thermal electric plants. A number of investment agreements have been reached for this purpose. Guangdong and Yunnan cooperated in developing four cascade power stations on the middle and lower reaches of the Lancang Jiang with a combined capacity of almost 10 million kW. The early stage work on the Xiaowan station was accelerated; using 500 kV dc transmission, the electricity was sent directly to Guangzhou. Guangdong paid 40 percent of the early stage fee and the Ministry of Energy paid 60 percent. The target date for construction is 1996 and the target date for operation is 2004. In the meantime, the ministry has also accelerated the front-end preparation of cascade hydropower stations at Dachashan, Nuozhadu, and Jinhong. Another joint venture is the 800 MW Baishui thermal power plant at Qujing. The first phase is for three 200,000 kW generators and the associated power transmission engineering construction. Guangdong will pay 60 percent of the total investment, Yunnan will pay 20 percent and the Ministry of Energy investment company will pay the remaining 20 percent. The target operation date is 1991 and the plant is expected to provide Guangdong with 200,000 kW of power during high water seasons. The plant will be operated and

managed by the Guizhou Provincial Electric Power Office based on the investment percentage and ownership of the various investors. Guangdong, Guangxi, and Guizhou cooperated in building the Tianshengqiao first and second level power stations on the Nanpan Jiang and Hongshui He (installing 1.2 million kW and 440,000 kW units). Guangdong, Guizhou, and the Energy Investment Company have reached an agreement on the development of the Anshun thermal power plant, a 2.40 million kW plant with a first phase of 2 x 300,000 kW. Guangxi, Guizhou, and the Energy Investment Company have also entered an agreement for the development of the Panxian thermal power plant (600,000 kW). These activities are the encouraging first step in making the southwest China's largest energy center based on hydroelectric power and supplemented by thermal power and in achieving the west-to-east power transmission. Fourth, the three provincial governments in the southwest have each invited renowned experts, scholars, professors, and leaders in hydroelectric construction and made comprehensive studies of the region containing Lancang Jiang, Wu Jiang, and the three rivers in Sichuan (Jingsha Jiang, Yalong Jiang, and Dadu He). These experts have made specific and practical evaluation and recommendations on how to accelerate the hydroelectric construction in the southwest, how to alleviate the electric power shortage, and how to develop the economy and achieving west-to-east power transmission. A consulting report on the development of Lancang Jiang and Wu Jiang in Yunnan and Guizhou was submitted to the State Council. Fifth, important sections of the five major rivers in the southwest have been surveyed and planned over the years by the Institute of Hydroelectric Power Survey and Design of the three provinces. Some preferred stations have already made considerable progress in the early preparation work; on this basis, they are in a good position to speed up the construction.

To summarize the above discussion, the development of the hydroelectric power in the southwest and the west-to-east power transmission are not only possible, but should be done immediately.

Of course, the task is formidable and the time is urgent. Problems to be studied include concepts and understanding, organization and leadership, capital raising, management system, and how to speed up the early stage of work. Scientific problems in the west-to-east power transmission include super high voltage and short distance power transmission, key technology in building 300-meter-high dams on basalt, and the manufacture of large water turbine generators for 200-meter water heads, 0.70-1.00 million kW units. These problems must all be studied carefully and scientific and sensible conclusions must be reached as part of the technological base in the development of the hydroelectric power in the southwest.

**Views on Developing Electric Industry Presented**

906B0018A Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 10, 5 Oct 89 pp2-6

[Article by Shi Dazhen [0670 1129 2823] of the Ministry of Energy]

[Text] Since the establishment of the People's Republic of China, there have been a number of electric power shortages; but the last episode of electric power shortage lasted 18 years. Even though in the first 3 years of the Seventh 5-Year Plan an average of 9 million kilowatts of new generator capacity was added each year, and the rate of increase of the average power production was more than 9.2 percent, but compared to the rate of growth of the national economy, the elastic coefficient of the electric power was only about 0.6 percent, and showed a drop in 1989. From another perspective, the ratio of new power generating capacity to new power consumption capacity in 1988 was 1 to 2.8. Hence, the excessive growth rate in the national economy and the excessive investment in new power consumption enterprises are the basic reasons for shortages in electric power. Why, then, over a long period of time the elasticity coefficient of electric power failed to meet the needs of national economic development? Why are the power consumption enterprises continuing to receive development capital? These are the issues for us to study and analyze. Only when there is a consensus on these issues, can there be workable solutions. To this end, I would like to present my views and to call upon more people to become concerned with the major issue in the industrial development of the electric power.

**I. Macroscopically Determine the Primary Energy Sources and the Elastic Coefficient of Electric Power Suited for Normal Development of the National Economy**

Determination of the primary energy sources and the elastic coefficient of the electric power is a major issue in the planning of the national economy. It is also a major issue in the well-proportioned development of the national economy and the energy sources and the electric power industry. The electric power shortage that lasted for 18 years is an out-of-balance phenomenon due to the lack of macroscopic proportion to follow. In the past the investment in energy resources and electric power development was determined by the financial distribution. Even though there was financial growth each year, the investment in energy saw almost no increase; in fact, the investment last year was actually about 2 billion yuan less than that for the year before. Whenever the financial situation was tight, the investment in electric power was cut back. Investments in energy and electric power have never acquired the status of strategic basic industry. When the economic development was constrained by shortages in energy and electricity, major adjustments were still not made in industrial and investment structure. It can be said that the electric power industrial investment was arbitrarily influenced by factors that violated the rules of economic development. In the

implementation of the decisions of the 3d Plenum Session of the 13th Party Central Committee, if the investments on processing industry, country and village industry, and high energy consumption industry (not including national projects) were not checked and limited, then the shortages in coal and electricity will further deteriorate and the instability in the national economic development will worsen.

What kind of energy and electric power elasticity coefficient will be suitable for the national economic development? In other countries where the industrial structure is healthy and advanced, the general rule for the electric power elasticity coefficient during rapid economic development is that it be greater than 1. That is, the growth of electric power is faster than the growth of the national economy. Only then can the national economic development be based on energy and electric power and the economic development be stable. In that case plants will never have to operate only 3 or 4 days in a week. On the other hand, China has a large population and a weak economy, its energy resources are distributed unevenly, and its transportation system is inadequate. Hence, it is difficult for China to maintain a high level of energy supply and a large elastic coefficient for electric power while keeping everyone fed. We should investigate China's energy and electric power on the basis of the Sixth 5-Year Plan and the first 2 years of the Seventh 5-Year Plan, shown in Table 1.

**Table 1. Growth in National Agriculture and Industry, Energy and Electric Power, and Their Elastic Coefficient**

Time/Category	Sixth 5-Year Plan (1981-1985)	First 2 years in Seventh 5-Year Plan (1986-1987)
Growth in national agriculture and industry gross value of production (percent)	68	28
Growth in primary energy resources (percent)	34	6
Growth in electric power production (percent)	37	20
Elastic coefficient of primary energy	0.50	0.21
Elastic coefficient of electric power	0.54	0.71

The data in Table 1 reveals two problems. First, the elastic coefficients for energy and electric power in the Sixth 5-Year Plan were respectively 0.50 and 0.54. The entire Sixth 5-Year Plan period was under a shortage of electric power. The annual growth of 13.6 percent of the national economy was achieved while many enterprises were only operating 3 or 4 days out of the week. This has clearly demonstrated that the shortage in electric power can be gotten rid of only by adjusting the investment structure, increase the proportion of investment on the energy and power industry, and reduce the investments on other power consuming enterprises. The second problem was that the power shortage of the Sixth 5-Year

Plan did not improve in the Seventh 5-Year Plan even though the electric power elastic coefficient has increased from 0.54 to 0.71. This was because the primary energy resource elastic coefficient decreased from 0.50 in the Sixth 5-Year Plan to 0.21. Not only the shortage of electric power did not improve, the acute shortage of coal and the stress in transportation forced China to deal with economic development by practicing setting production by electric power and setting electric power by the availability of coal. As a result, the shortage in electric power and energy in late 1988 and 1989 was even worse than that during the Sixth 5-Year Plan. In addition, the uncontrolled autonomy of rural enterprises, the double tracked pricing system and the price raising prevented the mainstay enterprises from receiving guaranteed energy supply. With the exception of the northwestern grid, other major power grids all showed negative growth in the ability to provide electric power in the first quarter of 1989. Almost 8 billion kilowatts of thermal power facilities put into operation in 1988 did not play its full role. The fact was that the investment on coal has dropped since the last part of the Sixth 5-Year Plan and the supply of coal in the first 2 years of the Seventh 5-Year Plan could not meet the demand. This shortage of coal has affected not only the development of power but also the national economy. Because the development of coal and electric power could not be synchronized, it resulted in the apparent phenomenon of an electric power that was developing "too fast." If the investment in electric power were suppressed in order to suit the shortage of coal and the investments in other energy intensive industries were not checked with determination, then the worsening shortage in coal and electricity will severely affect the national economy and people's lives in the Eighth 5-Year Plan. In order to prevent this from happening, the Ministry of Energy recommended in its planning for the year 2000 that energy resources and electric power should have elastic coefficients of 0.5 and 1.0, respectively. I believe that this recommendation is right for China. It should be pointed out that an energy resource coefficient no less than 0.5 is consistent with the overall target for energy conservation in China. In the next 12 years the energy consumption for the industrial and agricultural value of production must be reduced by 42 percent in order to balance the demand and supply of energy.

## **II. After Determining the Elastic Coefficient for Primary Energy and Electric Power, Investments in Energy Must Be Ensured**

Industrially advanced nations of the world have an investment in capital construction in energy equal to 23 percent of their fixed asset total investment. In comparison, China's investment in energy construction appeared inadequate. Even in the highest year, the energy investment was only 17 percent of the fixed asset investment. Insufficient investment in energy may be said to be the result of an irrational investment structure.

Since the energy needs were not guaranteed, it led to long-lasting power shortages and today's shortage in coal supply.

In the power industry the funds for major overhaul (currently equal to 1.4 percent of fixed assets) and renovation funds (3.9 percent of fixed assets) are also far below the national average. China spends more than 10 billion yuan on technical improvement, but the electric power industry is not getting any. All these have put the power industry in a very difficult situation for capital construction and production. If no policies were established to change the irrational industrial and investment structure, then, even though theoretically the elastic coefficient of electric power should be no less than 1 in the year 2000, the reality will be "one cannot make an omelet without eggs."

Of course, after years of reform and opening up, investments in the power industry have already showed some diversification and the new policies have promoted this diversification. Under the condition of scarce national resources, an important policy in the construction of the power industry is to mobilize the various areas in order to speed up the pace of electric power development. We must carry out this policy using every means at our disposal and strive to perfect other related policies so that the development of electric power will be done by many departments.

For example, the Huaneng Company has been building power stations since 1984 using funds generated in the switch from oil to coal; to date almost 5 million kilowatts of power generating facilities have been built and another 5 million kilowatts are expected to be built in the Eighth 5-Year Plan. The problems now are the lack of investments on hydropower and the unbalanced investments among the different regions. Another example is the east China power grid. Since 1985 the east China power grid has charged an extra 0.02 yuan for each kilowatt-hour it sold to build up an electric power construction foundation. Today, the grid receives more than 700 million yuan per year for this item alone. This practice has since been approved by the State Council and implemented nationwide since January 1988. This foundation has a bright future as it will grow as the sale of electric power increases. A problem existing in the east China power grid is also a lack of hydropower investment; some places even use the foundation money in the development of small thermal power with a high coal consumption. The usage of the foundation money must therefore be regulated and monitored.

In terms of financial sources for electric power construction, there is also the Shajiao-B plant in Guangdong Province financed jointly by Chinese and foreign money and the Daya Bay nuclear power plant, also a joint venture. For places with the ability to repay the foreign exchange, the Ministry of Energy is actively supporting the development of electric power by foreign loan, joint funding, merchandise exchanging, and trade compensation in order to accelerate the development of China's electric power industry.

On the whole, if China's power industry is to become independent and complete, it must eventually implement price reform and set the price based on the principle of the average rate of profit for the whole society. When the profit becomes too high or too low, the tax rate may be adjusted to regulate the profit.

**III. After Attaining Guaranteed Elastic Coefficient for Electric Power and for Funding Sources, Make Optimum Use of the Limited Funds, Shorten the Construction Time, Start Production as Early as Possible for Better Economic and Social Benefits**

In the area of capital construction for electric power, we have always insisted on the policy of "safety, quality, efficiency, and conservation." Since the beginning of reform and openness we have also implemented a bidding system on design and engineering projects. In the construction business, a contract system was set up for wages that led to 100 yuan production value and awards were given for construction completed ahead of schedule. These actions have greatly stimulated the enterprise and the construction crew; for 2 consecutive years the annual installation of generators was about 10 million kilowatts. In an effort to shorten the construction time, especially for thermal power plants, a number of power plants with single generator capacity of 200,000 kilowatts or more have taken less than 24 months from ground-breaking to the first generator coming on-line. These power plants included the Shajiao-B plant, the Dalian No 4 plant, the Xingtai power plant, and the Zouxian power plant. The installation of the two 350,000 kW generators at Shajiao, for example, took place 9 months ahead of schedule. This shortened construction time not only saved the investors interests, but also generated substantial economic benefits because the production began earlier, the recovery of the investment was accelerated and the shortage in electric power was alleviated. In the past when construction cycles were discussed, little consideration was given to investment interest, investment recovery, and the turn-around of fund. These new concepts must now be stressed and firmly established. Leaders should set their goals based on these concepts in order to keep all the engineering projects on a

reasonable construction schedule. Proper construction of course requires certain material resources, such as adequate and timely supply of fund, material, and equipment. In addition, problems with the quality of workers and equipment also need to be solved. An engineering project leader cognizant of the proper construction method will know how to organize the workers and carry out the construction in a solid manner. The leader will actively reach out and seek the support of the various departments involved in order to shorten the construction cycle. Although the construction of various hydroelectric power plants differ in the amount of civil engineering and concrete poured, the pace of construction will be accelerated by making the same efforts, these include formulating a reasonable construction schedule and adjusting to the competition in engineering bidding. Besides, the construction profession today is much better equipped than it was in the 1950's and 1960's, so that the construction cycle should be shortened accordingly.

**IV. The Policy of Stressing Electric Power Construction and Energy Conservation Must Be Adhered to Over the Long Term in China**

The economic standard of China puts it in the rank of developing nations; however, the amount of energy consumption per \$100 million of economic value of production in China is far greater than that of economic strong powers in the First and Second Worlds. Even in the Third World, China is also a big energy consumer. The whole Chinese society must pay attention to energy conservation. Table 2 shows the severity of the energy consumption problem in China and the potential gain for conservation.

**Table 2. Comparison of Energy Consumption per \$100 Million of Production Value**

China	France	Japan	India
1.0	0.2	0.23	0.6

The Ministry of Energy maintains that in order to quadruple the 1980 gross value of production of the national economy by the end of this century, the targets in energy development shown in Table 3 must be achieved.

**Table 3. Targets for 2000 in Energy Resources and Electric Power in China**

Gross value of production of primary and secondary energy (tons of standard coal)	Raw coal output (tons)	Crude oil output (tons)	Natural gas output (m <sup>3</sup> )	Capacity of installed electric generators (millions of kW)	Annual output of electricity (million kWh)
1.43 billion yuan	1.4 billion yuan	200 million yuan	30 billion yuan	2.4	12,000

It must be pointed out that, based on the figures in Table 3, the demand and supply of energy can be balanced only if the energy consumption per unit of the gross value in the national economic production is reduced from the present level by 42 percent. Clearly we must on the one hand work on conservation and on the other hand develop tomorrow's energy. In view of China's particular economic situation, the two-prong policy of conservation and development must be adhered to in the long term. If only one

aspect is stressed while the other is ignored, the target of quadrupling China's economy by the year 2000 will be seriously jeopardized.

In the last few years China followed a policy of openness and improving the industrial economic efficiency and achieved some results in conservation. Data showed that from 1981 to 1988 the national gross value of production in China increased 10.1 percent while the energy consump-

tion only increased 5.2 percent. We should therefore have confidence in our energy policy and establish energy legislation and practical conservation regulations as soon as possible. The preference of technical improvement loan should also be shifted toward conservation in order to devote more investment on energy conservation technology. Energy wasteful old facilities and outdated technology should be systematically and orderly reformed. A major effort should be made in the promotion of conservation so that every family and everybody become energy conscientious. Individuals and units making remarkable contribution to conservation should be rewarded.

**V. Problems To Be Noticed in the Electric Power Industry Under the Present Shortage in Coal, Electricity, and Transportation Capacity**

1. In planning the power stations, mining sites, highway junctions, and ports should be fully used. Power to load centers are to be supplied through long distance transmission. In the long term, regions with economic development potential but in shortage of coal and transportation should be considered for nuclear power development. Regions with water resources should speed up their development of hydroelectric power in order to reduce the pressure on coal and transportation. In short, the utilization of the primary energy resources should suit the local situation and the mixing of the primary and secondary resources should be optimized.

2. In the production of energy, the Ministry of Energy should match the demand and supply of the various industries so that the potential of the primary and secondary energy resources is fully exploited. The distribution of coal should be completed every year as early as possible; first satisfying the needs of the power generation industry and then distributing to the other industries according to the urgency of their needs. Based on the same principle, the distribution of electric power

should also first satisfy the needs to boost the production of coal and oil. When the nuclear power plants are in operation in the future, the power demands in developing the nuclear power system should come first; coal, electricity and oil should never impede one another.

For qualified coal and electricity capital construction projects we advocate joint operation. Repetition in investment should be avoided in the planning, design, construction, and production of coal and electricity. The production process should be well integrated so that the advantage of combining the development of coal and electricity can be realized.

3. Every year some wasteful, old generators beyond remodeling should be retired so as to increase the efficiency of coal utilization. In a period of several years or longer, 13 million kilowatts of old generation equipment should be replaced by large generators. This alone would save China 15 million tons of coal per year.

4. Make an effort to succeed in the co-generation of heat and electricity in China's smaller boilers not used in electric power generation. It has been estimated that there are about 400,000 small boilers in China, consuming one-third of the annual output of coal. If these boilers can be converted to co-produce heat and electricity in a few years or longer, then a substantial increase in electricity output can be realized even if the coal consumption remains the same.

In summary, the solution of the problems discussed here will encounter many difficulties. Today the industrial reform is taking root, these problems should be addressed in terms of definitive reform requirement and goals. The solutions should be implemented solidly and step by step based on the resources of the society and the enterprises. I believe that China will be able to develop an approach for electric power that suits the situation in China.

**Sichuan's Power Construction Sets Record**

40130132B Chengdu *SICHUAN RIBAO* in Chinese 3  
Aug 89 p 1

[Article by Zhu Yurong [2612 3768 2837] and Lan Wenjian [5695 2429 0494]: "Sichuan Province Sets an Electric Power Construction Record in 1989—1,000 MW of Installed Electric Power Generators To Go Into Operation and Basically Be Completed"]

[Text] Sichuan Province plans to place into operation and basically complete 1,000 MW of installed electric power generators during 1989, the highest for any year since liberation and more than three times the amount of installed generators completed and placed into operation in the Sichuan Power Grid during the entire Sixth 5-Year Plan.

Plan arrangements by central authorities and Sichuan Province call for planned investments in electric power construction in Sichuan during 1989 to rise from a base figure of more than 1.5 billion yuan in 1988 to over 2

billion yuan. The 1,000 MW in electric power projects whose start of operation and completion are planned for 1989 are: the 200,000 kW No 2 generator at Baima Power Plant at Nei Jiang, which was connected to the grid and generated power ahead of schedule on 26 February; the 25,000 kW No 1 generator at Longqiao Power Plant at Fuling and the two 36,000 kW No 1 and No 2 gas-fired generators at Chongqing which may begin operation and generate power in 1989; and the 330,000 kW No 7 generator at Jiangyou Power Plant and a new 200,000 kW generator at Chengdu Power Plant planned for testing during joint operation before the end of 1989.

Some 200,000 kW in medium-sized and small hydropower and thermal power generators will go into operation during 1989. By the end of April 1989, 45,000 kW had already begun operating at Xiushan Thermal Power Plant and other power stations. Equipment installation and debugging is being speeded up at Shiqiao Hydropower Station at Jianyang, Guankou Thermal Power Plant at Pengxian, and other power stations.

## Outlook for Hydropower Development to the Year 2000

906B0004 Shanghai DONGLI GONGCHENG  
in Chinese Vol 9 No 4, Aug 89 pp 14-16

[Article by Bian Shanqing [6708 0810 1987] of the China Electric Power Equipment Corporation: "Tentative Ideas for Developing Hydropower in China to the Year 2000"]

### [Text] Abstract

This article offers estimates and planning ideas concerning the basic situation in hydropower and lists ways to raise the needed funds. It describes three tentative programs for adding 54,000, 66,000, and 78,000 MW in installed generating capacity for developing hydropower development to the year 2000.

Main terms: hydropower, development, planning

On 23 December 1988, the Ministry of Energy Resources Comprehensive Planning Department held a meeting on "energy resource development planning programs for the year 2000" to discuss basic principles, development goals, and strategic deployments for China's energy resource industry in the year 2000. The "planning programs" did not fully embody the energy resource policy of "gradually shifting the focus to hydropower." Beginning with the long-term view of developing China's electric power industry, a reduction in our present shortage of energy resources and electric power means that preferential development of hydropower has an extremely important strategic importance and real significance. I will now offer an estimation of the basic situation in hydropower and provide some tentative ideas and countermeasures for development.

### I. The Basic Situation

China's installed hydropower generating capacity has grown from 360 MW in 1949 to more than 30,000 MW since the nation was founded, and annual power output has grown from 710 million kWh to more than 100 billion kWh. The largest installed generating capacity, at Gezhouba Hydropower Station, has now reached 2,715 MW. The largest single-unit generator capacity, at Longyang Gorge Hydropower Station, is a 320 MW water turbine generator. China has made substantial achievements in hydropower construction, but the pace of development has not corresponded to our extremely abundant hydropower resources and glorious modernized construction industry. There is a rather national serious power shortage and many enterprises have shut down because they lack power. Some production capacity is not being fully utilized now, which has restricted development of the national economy.

China's total installed generating capacity at the end of 1987 was 102,897 MW, with yearly power output of 497.3 billion kWh. Hydropower accounted for 30,193 MW or 29.3 percent. Power output from hydropower was 100.2 billion kWh or 20.1 percent. The ratio

between the installed generating capacity in hydropower and thermal power is about 3:7 and the ratio in yearly power output is about 2:8. These ratios have remained about the same for almost 20 years beginning in 1970. Obviously, thermal power continues to dominate electric power construction and production in China and inadequate attention has been given to hydropower. This is the basic reason for slow development of hydropower in China.

Because China's power comes mainly from the conversion of coal, it is restricted to a substantial degree by coal production and transport. During the Seventh 5-Year Plan, China added 117 billion kWh in new thermal power output, more than double the amount in the Sixth 5-Year Plan, and coal use increased by over 69 million tons. With the added growth in iron and steel output, there was a substantial national coal shortage during the Seventh 5-Year Plan. China now has proven coal reserves of 780 billion tons. About half, 390 billion tons, is coal used for motive power. Calculated at a maximum average recovery rate of 50 percent, 195 billion tons can be extracted. About 1.92 trillion kWh of power could be produced annually from our theoretical hydropower reserves of 680 million kW, equivalent to a yearly increase of 1 billion tons of raw coal for thermal power. Calculated at a lifetime of 100 years for hydraulic structures, this would be 100 billion tons. One can see that hydropower resources occupy a relatively important status in the two main resources used by the electric power industry. Moreover, coal is a non-renewable energy resource, whereas hydropower resources are a cyclical renewable energy resource. Allowing them to remain undeveloped and flow unused into the sea is an enormous waste of energy resources.

Most of the world's industrially developed nations gave preference to developing hydropower. After developing all or nearly all of their developable hydropower resources, many countries shifted the focus of their electric power production policies to thermal power or nuclear power. China holds first place in the world in hydropower resources but only a very small proportion has been developed so far. Thus, in starting with real conditions, preference for developing hydropower and actively increasing hydropower as a proportion of energy resources should be a long-term strategic principle for developing China's energy resources and improving our energy structure.

### II. Tentative Planning Ideas

To ensure that the requirement of quadrupling the gross value of industrial and agricultural output by the year 2000 is met, electric power production must at least quadruple, with the national installed generating capacity increasing from 65,870 MW in 1980 to 263,000 MW and yearly power output increasing from 300.6 billion kWh to 1.2 trillion kWh. If synchronization in hydropower plans is maintained, the installed hydropower generating capacity must increase from the 1980 level of 20,320 MW to 80,000 MW, meaning an

addition of 60,000 MW in installed generating capacity, and yearly power output must increase from 58.2 billion kWh to 230 billion kWh. This would mean that the installed generating capacity and yearly power output from hydropower would still be held at the relatively low levels of the past and there would still be no consideration of increasing the proportion of hydropower.

How can the principle of preferential development of hydropower be achieved? I feel that two concrete indicators can be used for evaluation. One is to increase the hydropower development and utilization rate. The other is to increase the proportion of the installed generating capacity from hydropower. To meet the requirement for quadrupling output mentioned above, with an installed hydropower generating capacity of 80,000 MW and yearly power output of 230 billion kWh in the year 2000, this would mean a development and utilization rate of just 12 percent relative to the 1.92 trillion kWh of China's developable hydropower resources. Statistics for 1980 show that the world had developed 460,000 MW in installed hydropower generating capacity with yearly power output of 1.75 trillion kWh, which is an average development and utilization rate of 18 percent relative to the world's 9.8 trillion kWh of developable hydropower resources. Concerning forecasts for future hydropower development, the World Energy Conference estimated in 1980 that the amount will roughly double from 1980 to 2000, with yearly world electric power output from hydropower reaching 3.54 trillion kWh, an average development and utilization rate of 36 percent. Compared to this, the utilization rate for China's developed hydropower is relatively low.

Starting with real conditions in China and assuming that China's hydropower development and utilization in 2000 will attain the world's 1980 average development level of 18 percent, yearly power output should reach 340 billion kWh with a corresponding installed hydropower generating capacity of about 92,000 MW. At that time, the ratio of hydropower to thermal power installed generating capacity will be:

Hydropower =  $92,000/263,000 \times 100$  percent = 34.98 percent

Thermal power =  $171,000/263,000 \times 100$  percent = 65.02 percent

This raises the original 3:7 ratio between hydropower and thermal power installed generating capacity to 3.5:6.5. This program is somewhat capable of achieving a faster pace of hydropower development. If the ratio between the hydropower and thermal power installed generating capacities is increased to 4:6 by the year 2000, the installed hydropower generating capacity should reach 100,000 MW, equivalent to yearly power output of 370 billion kWh. The hydropower development and utilization rate would be 19.3 percent, still below 20 percent. Although this is still somewhat low compared to the world's average level of development, it is a higher level hydropower development program for China. We must, however, make a firm decision now to focus on it if we are to attain it.

Table 1 lists the concrete ideas for adding installed generating capacity during each period from 1986 to 2000 for the three programs outlined above.

**Table 1. Three Tentative Programs for Adding Installed Hydropower Generating Capacity From 1986 to 2000**

Development program/Period	Seventh 5-Year Plan, 1986-1990	Eighth 5-Year Plan, 1991-1995	Ninth 5-Year Plan, 1996-2000	Total additions to installed hydropower generating capacity over 15 years (MW)	Average (MW)
I. Addition to installed generating capacity (MW)	9,000	18,000	27,000	54,000	3,600
Total installed generating capacity (MW)	35,420	53,420	80,420		
II. Addition to installed generating capacity (MW)	10,000	22,000	34,000	66,000	4,400
Total installed generating capacity (MW)	36,420	58,420	92,420		
III. Addition to installed generating capacity (MW)	12,000	28,000	38,000	78,000	5,200
Total installed generating capacity (MW)	38,420	66,420	104,420		

The three tentative programs for hydropower development outlined above are based on the preparatory work for hydropower station surveying and design that can be done in the short term, on equipment manufacturing capacity and construction capacity, and on basic existing conditions. China's hydropower construction capacity

and equipment manufacturing capacity have now reached a definite level. We now have the capability of excavating 40 million cubic meters of earthworks and pouring 5 million cubic meters of concrete annually. We have reached a large and medium scale hydropower equipment and small scale hydropower equipment manufacturing

capacity of 3,000 MW. China now has over 50,000 hydropower survey and design workers with a very strong design capacity.

This also is the foundation and prerequisite for China to accelerate hydropower construction. During the process of implementing hydropower, we often encounter restrictions by problems like resettlement of people from regions to be flooded by reservoirs, inadequate capital, and so on, so it will be extremely hard to attain an installed hydropower generating capacity of 100,000 MW by the end of this century. However, these concrete problems can be solved through our efforts if we do intensive and detailed macro research, rationally arrange the proportional relationship of hydropower in investments in the electric power industry, and earnestly study and formulate some basic policies for accelerating hydropower development.

### III. Ways To Raise Capital

China is now in a period of construction and inadequate funds are one factor which restricts hydropower construction and development. During more than 30 years of hydropower construction in China, large and medium scale hydropower stations usually were built with state investments (or loans) while small scale hydropower stations mainly depended on capital raised by localities themselves with some state subsidies. Based on the tentative planning ideas for 1986 to 2000 outlined above, the construction funds of more than 100 billion yuan required to accelerate hydropower development will average 7 to 8 billion yuan yearly. Obviously, it will be hard to depend entirely on state capital construction investments for such a large amount of capital. In the current situation of relative shortages in state financial resources, adopting the method of raising capital from multiple sources would be one effective way to accelerate the development of hydropower.

To fully motivate the initiative of all regions, all departments, and all enterprises to raise capital to develop hydropower, we should break down regional and departmental boundaries to create a situation of using multiple forms, multiple layers, and multiple channels to develop hydropower. The method involves: 1) Implementing a method of compensated investment with each department using products as shares and setting prices according to products, with repayment of the principal and interest after power is generated. For example, construction departments can use cement as shares, equipment manufacturing departments can use electro-mechanical equipment as shares, construction departments can use construction machinery and labor as shares, and so on. 2) Investments for comprehensive utilization hydropower can be allocated among departments which benefit, with power and profits allocated according to the proportion of capital raised. 3) Issue hydropower stocks or bonds to collect the large amount of scattered capital in society and social savings, and especially welcome purchases by departments and units in regions with power shortages.

Hydropower is an investment-intensive industry and a large or medium scale hydropower station often requires several hundred million yuan in investments. If the state can provide some specific support, this would aid in attracting scattered local capital and greatly encourage local initiative to develop hydropower. Incomplete statistics show that state plans have approved construction of 22 medium scale hydropower stations over the past 2 years for a total installed generating capacity of 1,030 MW and total investments of 2 billion yuan. The state is providing 560 million yuan in loans or about one-fourth of the total investment, which means that four hydropower stations can be built for each hydropower station the state invests in. If local areas and enterprises can raise more capital, more hydropower stations could be built. A tendency has now appeared in China for multiple forms of capital raising to build hydropower stations. In November 1987, I visited Fancuo Hydropower Station in Jiangle County, Fujian Province. This power station has an installed generating capacity of 36 MW and cost 76 million yuan. All the funds were invested by the local area and enterprises. The county raised 35 percent of the funds and took responsibility for building a highway to the outside, requisitioning land and resettling the population, and the electricity used for construction. The Min Jiang Engineering Bureau in the Ministry of Water Resources and Electric Power raised 15 percent and was responsible for civil engineering construction, generator installation, and materials purchasing. The Fujian Provincial Electric Power Bureau raised 50 percent and was responsible for power transmission and transformation projects and matching construction, equipment production, and operation and regulation after startup. Fund sources for units which raised the investments included free capital, labor service fees, loans, and so on. Construction of Fancuo Hydropower Station did not just raise funds for hydropower station construction. It also solved problems which have faced hydropower construction for a long time like difficulties in requisitioning land, difficulties in resettling people, large capital construction costs, high engineering costs, and so on, which have provided a beneficial enlightenment for China in accelerating hydropower construction.

### IV. Conclusion

As the national economy has grown, electric power has come to account for an ever-increasing proportion of energy resource consumption. It can be expected that after 2000, the growth rate in power consumption in China will exceed that of other energy resources. Beginning with China's long-term strategies for energy resource development, major efforts to conserve valuable coal and oil resources and accelerated development of hydropower resources to increase hydropower as a proportion of primary energy resources will be the most realistic way to improve our energy resource structure. Thus, we must formulate correct development strategies,

accelerate hydropower development, and strive to increase the installed hydropower generating capacity to 100,000 MW by the end of this century to alleviate China's long-term serious power shortage.

### **Nation's Hydropower Equipment Technology Said at Advanced World Levels**

906B0022B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 23 Nov 89 p 3

[Excerpts] The four 320,000-kilowatt turbine generating units of the Longyang Xia power station, the largest on the upper Huang He, have now come on line. More than 90 percent of its main machinery, main transformers, and other permanent equipment was domestically manufactured.

Chinese hydropower expert Luo Xibei is of the opinion that the design, manufacture, and installation of this equipment and its smooth operation indicates that in the area of developing permanent hydropower equipment technology, China has reached the advanced international levels of the 1980's.

The Longyang Xia power station, located in the northwestern part of the Qing Zang Plateau, in Qinghai Province's Zangzu Autonomous Region, is the first large-scale cascade power station on the upper Huang He. Its total installed capacity is 1.28 million kilowatts and its annual generation is 6 billion kilowatt-hours. Altogether, there are four water turbine generating units with generating capacities of 320,000 kilowatts each installed. The power station's large dam is 178 meters tall and the capacity of the reservoir is 24.7 billion cubic meters. It has been called a spigot Huang He project because it has the largest single unit generating capacity, the highest dam, and the largest reservoir.

The station's combined-flow type 320,000-kW turbine generating units were produced by Sichuan's Dongfang Electrical Machinery Factory of Deyang and installed by the Number 4 Hydraulics and Hydropower Engineering Bureau. Owing to close coordination between the factory and the construction unit, installation of these enormous units totaling over 10,800 tons installed, only required 21 months. On-grid generation was successful after one installation and start-up, a new record in the history of hydropower installation in China. [passage omitted]

This year, the Longyang Xia power station's domestically produced equipment passed the test of the second largest flood in 40 years. The power station has been of enormous economic benefit in both generating power and flood prevention. As of the end of August, the four generating units had generated 5.6 billion kilowatt-hours and the reservoir had stored 14.2 billion cubic meters of water.

During the flood season this year, the water stored in the station's reservoir increased by nearly 7 billion cubic meters, a stored energy of 1.8 billion kilowatt-hours.

### **60,000 Small Hydropower Stations Operational**

40100025C Beijing XINHUA in English  
1505 GMT 29 Jan 90

[Text] Beijing, January 29 (XINHUA)—By the end of last year China had set up 60,000 small hydropower stations with a combined generating capacity of 12.37 million kW and generating 34.3 billion kWh a year, says today's PEOPLE'S DAILY.

More than half the counties in China have exploited local water resources and at present more than 800 of them have their own small power networks.

The state started an electrification program for the first trial group of 100 counties in 1983. At present, 88 of them have formed their own power networks.

The per capita consumption of electricity within the 100 counties reached 200 kWh last year, up from less than 100 kWh before the program began 6 years ago. The gross value of industrial output from the counties has nearly doubled in the same period and per capita real income has shot up from 199 yuan to more than 500 yuan a year.

At the same time, the local authorities in provinces, autonomous regions and municipalities have collected funds and materials to fully use and develop rivers.

The state plans to build 100 medium-sized power stations with a combined capacity of 4 million kW to improve local power networks which rely on small hydropower stations.

### **Rapid Progress in Small Hydropower Projects**

906B0022C Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 23 Nov 89 p 3

[Text] Today, the installed capacity of China's small hydropower stations has reached 12 million kilowatts, accounting for 36.4 percent of the total installed hydroelectric capacity nationwide. The amount of electricity generated annually is 31.6 billion kilowatt-hours.

The director of the Department of Rural Hydropower of the Ministry of Water Resources, Deng Bingli, explained to Chinese and foreign firms which came the other day to attend the International Water Resources Exhibition that, as of the end of 1988, China had five provinces and regions, i.e., Guangdong, Sichuan, Hunan, Fujian, Guangxi, and Hubei in which the total installed small-scale hydropower capacity had exceeded 1 million kilowatts, and that the provinces of Yunnan, Zhejiang, Jiangxi, and Hubei have exceeded 500,000 kilowatts.

Deng Bingli said that since the beginning of 1986, the Government of China has invested 100 million yuan in the development of small-scale hydropower. Today, there are 70 counties nationwide which can fully supply 90 percent of rural families with electric power. He estimates that in the first half of 1990, 100 counties across the nation will have reached this standard.

Deng said that small-scale hydropower construction has not only solved the problem of electricity for lighting for farmers, it has also moderated the nationwide electric power shortage and has given impetus to village and rural enterprises, and to the development of agriculture. At the same time, small-scale hydropower has provided an inexpensive source of energy for field irrigation, field drainage, and the processing of auxiliary agricultural products. It has spurred the economic development of each region.

According to a water resource survey, the amount of small-scale hydropower in China which can be developed is 75 million kilowatts.

### **Present Status and Prospects of Hydropower in Fujian**

40130127A Beijing SHUILI FADIAN [WATER POWER] in Chinese No 7, 12 Jul 89 pp 6-9

[Article by Pan Zhongyu [3382 0112 7625] of the Fujian Provincial Water Conservancy and Hydropower Department: "Current Situation and Prospects for Hydropower Construction in Fujian Province"]

#### **[Text] I. Hydropower Resources of Fujian Province**

Fujian Province is relatively rich in hydropower resources. A 1978 survey showed that Fujian has 10,460 MW in hydropower reserves and 1,000 developable hydropower station sites with a single station installed generating capacity of 500 kW and up for a total installed generating capacity of 7,050 MW and yearly power output of 32 billion kWh. Statistics also show over 10,000 developable sites for micro hydropower stations with a single station installed generating capacity of 500 kW and less for a total installed generating capacity of 1,020 MW. The developable total for these two items is 8,700 MW. Particularly noteworthy is that these are renewable energy resources equivalent to 15 million tons of standard coal yearly (100-year statistics would be 1.5 billion tons of standard coal) which are located in east China along China's southeast coast. This region has a developed industry, a concentrated population, and is economically prosperous, but it has extreme shortages of energy resources. More development and utilization of these energy resources undoubtedly would contribute to implementation of the coastal economic development strategy.

#### **II. Current Situation in Hydropower Construction in Fujian Province**

Fujian was one of China's first provinces to build hydropower. Shortly after liberation, the Fujian Province CPC Committee and Fujian Provincial Government took a broad and long-term view by focusing on favorable conditions of Fujian Province's rich hydropower resources and quickly became involved in building Gutianxi Hydropower Station. Since the mid-1950's, a high tide of small scale hydropower motivated by Yongchun County also has risen up. After 30 years of

water conservancy and hydropower construction, Fujian Province had built hydropower stations with an installed generating capacity of 1,707 MW at the end of 1987 and another 1,950 MW of hydropower stations are under construction (including 1,400 MW at Shuikou and 225 MW at Shaxikou which has not gone into operation). When these hydropower stations are completed and begin operating, the hydropower development and utilization rate in Fujian Province will rise from 21.2 percent at the end of 1987 to 45.4 percent. This construction process forged a large contingent of provincial, prefectural, county, and township (town) electric power construction, scientific research, and production management workers numbering more than 60,000 and several counties can now independently design and build 10 MW grade hydropower stations and 110 kV grade power transmission and transformation projects. The installed generating capacity at these large and small hydropower stations accounts for 61 percent of Fujian's 2,800 MW in total installed electric power generating capacity at the end of 1987 and they produce 5.28 billion kWh of electricity, equal to 53.6 percent of Fujian Province's total power output of 9.85 billion kWh. Thus, hydropower now plays a dominant role and thermal power an auxiliary role in Fujian Province's electric power industry. This conforms to Fujian Province's actual situation of relatively abundant hydropower resources, limited coal (yearly raw coal output is 7.87 million tons), and lack of petroleum.

Of the 1,707 MW of installed generating capacity, a total of 745 MW is in hydropower stations with a single station installed generating capacity of 10 MW and up (including 10 MW), equal to 43.7 percent of the total installed hydropower generating capacity. The largest single station is Shaxikou Hydropower Station, with a total installed generating capacity of 300 MW, and one 75 MW unit (the largest single generator) has begun operating. There is a total of 561 MW at stations with a single station installed generating capacity of 500 kW to 10 MW (not including 10 MW), equal to 32.9 percent. Micro stations of less than 500 kW are located throughout Fujian and total 400 MW or 23.4 percent. This includes 154 MW with a single station installed generating capacity of less than 100 kW, equal to 9 percent.

Small scale hydropower can be found throughout Fujian Province with the exception of Dongshan and Jinjiang Counties. Of Fujian Province's 67 counties and suburban areas, 45 now have a total installed hydropower generating capacity of more than 10 MW, including 16 with more than 20 MW, seven with more than 30 MW, and Yong'an City which now has over 40 MW.

In 1987, 100 percent of Fujian Province's townships and towns, 94 percent of its villages, and 88 percent of its households had electricity. Power usage at and below the county level in Fujian Province totaled 4.468 billion kWh, while the amount of power supplied by local hydropower was 3.24 billion kWh, a self-sufficiency rate of 72.5 percent. Fujian has 47 counties which depend

mainly on small scale hydropower for electricity supplies. The amount of small scale hydropower in Fujian connected to the provincial grid is now 548.5 MW. Factory and mining enterprises under provincial jurisdiction and most of those under prefectural and city jurisdiction are provided with power directly by the Fujian Provincial Grid, and the reserve power plants of some large and medium scale enterprises also regulate surpluses and shortages with the provincial grid. Fujian Province now has 19 counties which have not connected to the provincial grid. The trend of the future is that the provincial grid will extend gradually into those counties which have not connected to the grid. During 1988, Yunxiao, Dongshan, Zhaoan, Jianning, Anxi, Ningde, and other counties were connected to the Fujian Provincial Grid or are now connecting to it. At the same time, most counties are making additional improvements or developments in their own county grids on their existing foundations, and they are connecting with the provincial grid at one or more points and establishing wholesale relationships for mutual regulation and exchange of power. Moreover, 110 kV power transmission and transformation projects are now appearing in certain counties.

Hydropower now dominates and will continue to dominate electric power supplies in Fujian Province during this century, but the few regulation reservoirs at already built hydropower stations mean that they have poor runoff regulation capabilities. The amount of runoff in Fujian Province's large and small rivers varies substantially during a single year. This limited flow seriously affects power output during the dry season (runoff during the dry season is generally only 15 to 25 percent of long-term average runoff) and there are major variations in runoff in different years (total runoff in a dry year is usually only about 60 percent of that during a wet year). For this reason, besides being concerned with building more reservoirs in future hydropower construction and especially building "tap" reservoirs which involve limited flooding on tributaries, the Fujian Provincial Grid should have a certain proportion of matching thermal power to meet power supply requirements during the dry season and dry years. Another characteristic of Fujian Province is the large amount of runoff during wet years which is usually drained off as floodwater by hydropower stations. To make full use of this seasonal electrical energy, Fujian Province has the conditions to develop high energy consuming seasonal users like ferrosilicon, crystalline silicon, and so on under guidance by plans to supply the state for domestic and export demand.

### III. Prospects for Future Hydropower Construction

Fujian Province is one of two provinces which have decided to implement special policies and flexible measures, and it is a trial region for comprehensive reforms. Xiamen Special Economic Zone is located in Fujian Province and some free port policies can be implemented. Fuzhou is one of China's 14 open coastal cities and Mawei Economic Development Zone is located in

the city. There also is the economically open Minnan Triangle Zone centered on Xiamen, Zhangzhou, and Quanzhou. Thus, in the future Fujian should play an important role in the "four windows and two radiations." This is particularly true of the rapid growth of economic relations with Taiwan since 1988, and Taiwan businessmen are competing to come to Fujian and build factories and run enterprises. In this political and economic situation, Fujian's national economy and social development should strive to stand among the front ranks in China. For historical reasons, however, current production levels in Fujian are very backward. The gross value of industrial and agricultural output, for example, was 31.188 billion yuan in 1987, with industry accounting for 23.284 billion yuan and agriculture for 7.904 billion yuan. National income was 16 billion yuan (22.622 billion yuan in 1987 prices), the GNP was 18.34 billion yuan (26.036 billion yuan in 1987 prices), and financial income was 3.316 billion yuan. Thus, we must strive to catch up to advanced levels in China.

Forecasts by relevant departments in Fujian indicate that power output in Fujian should reach 37 billion kWh in 2000, which is 3.75 times the 1987 figure of 9.854 billion kWh, an average yearly growth rate of 10.7 percent. At that time, the population of Fujian Province will be 32.85 million and the amount of power available per capita will be 1.126 kWh (it was 352 kWh in 1987). Projections are that the installed hydropower generating capacity in Fujian will reach 4,500 MW in the year 2000 and that the installed thermal power generating capacity will be 5,100 MW, for a total of 9,600 MW. Annual power output will be 16.5 billion kWh from hydropower and 20.5 billion kWh from thermal power. Annual coal consumption to generate power will be 11.2 million tons, most of which will have to be shipped in from other provinces. China now has a coal shortage and estimates are that it will be hard to solve for quite some time. To develop hydropower, the Ministry of Energy Resources has called for pushing forward with development of several medium scale hydropower stations. Fujian Province has extremely advantageous medium scale hydropower resource conditions. Given this situation, Fujian Province should build more medium and small scale hydropower as a substitute for excessive thermal power plant construction along coastal ports.

In summary, one cannot disagree with the principle that Fujian Province should try to develop more hydropower during this century. To assure stable power supplies, there also should be a certain proportion of matching thermal power.

Fujian Province has quite a bit of developable hydropower. Projects of more than 250 MW now under construction include Shaxikou Hydropower Station (installed generating capacity 300 MW, yearly power output 960 million kWh, and guaranteed output 50 MW) where two units for a total of 150 MW have now been completed, the 1,400 MW Shuikou Hydropower Station (yearly power 4.95 billion kWh and guaranteed output 260 MW) which is now actively under construction, and

the Mianhuatan Hydropower Station with its quite superior indices (installed generating capacity 600 MW, yearly power output 1.49 billion kWh, and guaranteed output 88.7 MW) which we are striving to complete by the end of this century. These three large scale hydropower stations have a total installed generating capacity of 2,300 MW, yearly power output of 7.4 billion kWh, and guaranteed output of 398.7 MW. Their reservoir capacity at normal high water levels is 4.2 billion cubic meters and they flooded a total of 67,000 mu of cultivated land and required resettlement of 99,000 people.

There are plans to build a perennial regulation reservoir on Muyang Xi in east Fujian at Qinshan (controlling a basin of 453 square kilometers) with a dam height of 118 meters, a reservoir capacity of 231 million cubic meters, installable generating capacity of 70 MW, yearly power output of 150 million kWh, and guaranteed output of 15.6 MW. Just 965 mu of land was flooded and 948 people resettled. They also plan to build the high head Zhouning Hydropower Station downstream from it which will have a maximum head of 428 meters, an installed generating capacity of 250 MW, yearly power output of 650 million kWh, and guaranteed output of 72 MW. Added together, these two cascades will have a total installed generating capacity of 320 MW, yearly power output of 800 million kWh, and guaranteed power output of 87.6 MW, with 1,157 mu of land flooded and 1,140 people resettled.

Moreover, Jiemian Hydropower Station on the tributary You Xi upstream from Shuikou Hydropower Station has a perennial regulation reservoir which controls a basin area of 2,986 square kilometers, has a reservoir capacity of 2.173 billion cubic meters, flooded 29,400 mu of cultivated land, and resettled 33,100 people. According to debate by the Fujian Provincial Grid on the role of electric power compensation, the installed generating capacity could be as high as 400 MW with guaranteed output of 116.2 MW during the dry season and a basic yearly output grade of 598 million kWh. Its role in peak regulation during the wet season could reduce the discarding of water at other hydropower stations in the grid and increase yearly power output by 775 million kWh. It also could increase dry season output at Shuikou Hydropower Station to 48.5 MW. We should try to build Jiemian Hydropower Station after Shuikou Hydropower Station is basically completed.

Other sites with hydropower resources in excess of 100 MW in Fujian Province include Anfengqiao on the Jian Xi, Xindian on the Dazhang Xi, Dongkou on the Jiao Xi, and Huokou on the Ao Jiang. To reduce flooding losses at Anfengqiao Hydropower Station on the Jian Xi, the East China Survey and Design Academy is now studying low-head development using existing flow guide tunnels and concrete cofferdams. The other three sites will not be considered temporarily during this century due to inundation relationships.

Fujian Province is especially rich in hydropower resources of 10 to 100 MW (including 10 MW). It has 2,150 MW but only 400 MW had been developed up to the end of 1987, a utilization rate of just 18.6 percent. This grade of medium-sized hydropower stations has an appropriate scale and each project costs several 10 million to 200 million-plus yuan, so it is easier to raise the funds. Construction usually takes about 3 years, relatively little cultivated land is flooded, and they can be integrated with irrigation, industry, urban and rural residential water supplies, water-borne transport, and other forms of comprehensive utilization and economic diversification. Local areas and counties are quite enthusiastic and they can give preference to providing local water and power supplies, developing water-borne transport, and other comprehensive management issues. Those now under construction include Fancuo Hydropower Station at Jiangle with an installed generating capacity of 36 MW, where one 18 MW unit was completed during 1988; Yushan Hydropower Station at Jian'ou with an installed generating capacity of 24 MW, which may be completed in 1989; Longmentan reservoir and first cascade hydropower station at Dehua with an installed generating capacity of 18 MW, which may be completed in 1989 and second cascade 24 MW power station where construction has begun; and Liangqian Hydropower Station at Taining with an installed generating capacity of 30 MW where construction began in 1988. Others include Shanfeng at Liancheng, Shangban at Yong'an, Fuquanxi second cascade at Yongtai, and other hydropower stations, each with a 10 MW installed generating capacity and now under construction. There also is Chenqian Hydropower Station with a design scale of 16 MW. Two 3.2 MW generators have been completed and are producing power and an expansion of three additional generators is now under way. These 10 MW-plus hydropower stations now under construction can provide an additional 170 MW in installed generating capacity and all of them will be completed and begin operation in 1989 or 1990.

Fujian Province has been extremely concerned with reserve hydropower station projects in the 10 to 100 MW grade. We have done several basin plans, feasibility research, preliminary designs, and other preparatory work and selected 18 projects from among them (including Qinshan and Zhouning at Muyang) with a total installed generating capacity of 911 MW, yearly power output of 3.05 billion kWh, and guaranteed output of 244 MW. Construction of these 18 medium scale hydropower station projects will begin in the near term when conditions are ripe. Preliminary designs have been prepared for most of them. The principles guiding our selection were that besides technical and economic feasibility, these points also had to be considered:

1. Concern for building "tap" reservoirs in several basins with large heads for regulation of all cascades of already built or unbuilt hydropower stations downstream to increase dry season output capacity and gradually transform Fujian Province's fragile structure of too many runoff power stations.

2. Using the regulatory role of Fujian's two larger reservoirs at Ansha and Chitan and a comprehensive utilization cascade of their lower reaches in conjunction with developing water-borne transport on the Sha Xi, Futun Xi, and Jin Xi, tributaries of the lower Min Jiang.

3. Giving preference to developing high head hydropower stations with good economic benefits and striving to match them up with several regulation reservoirs.

4. Actively supporting development of hydropower resources in the two "old revolutionary base area, minority area, and frontier region" poor regions of Ningde and Longyan.

Besides these 18 projects, a second group of projects is available for selection. In summary, if the state provides specific economic support, particularly preferential treatment in policies, Fujian Province may contribute to more construction of several medium scale hydropower stations.

As for small scale hydropower stations under 10 MW (not including 10 MW), some 50 to 60 MW have begun operating over the past few years. All counties are now mainly developing backbone power stations of a few MW to 10 MW while townships and towns are mainly developing power stations over 500 kW. Estimates are that over the 13-year period up to the year 2000, they can place 700 MW with yearly power output of 3 billion kWh and guaranteed output of 170 MW into operation by relying mainly on "using power to develop power" and the economic strengths of counties and of townships and towns. We now have a total installed generating capacity of 400 MW in micro hydropower stations under 500 kW and estimates are that over one-half of those with poor efficiency will be replaced by backbone power stations by the year 2000. An estimated 240 MW will be abandoned, with average yearly power output of 500 million kWh, guaranteed output of 40 MW, and dry year power output of 200 million kWh.

For this reason, tentative plans call for adding 4,080 MW in installed hydropower generating capacity by 2000 to attain a total installed generating capacity of 5,550 MW and yearly power output of 21.2 billion kWh. Fujian Province's hydropower development and utilization rate will reach 68.6 percent.

Fujian Province's projected total thermal power and hydropower installed generating capacity will reach 8,930 MW in the year 2000, including 5,550 MW or 62 percent from hydropower and 3,380 MW or 38 percent from thermal power. Long-term average yearly output will be 21.2 billion kWh from hydropower and 15.8 billion kWh from thermal power. Dry year power output will be 13.5 billion kWh from hydropower and 23.5 billion kWh from thermal power. Guaranteed output will be 1,310 MW from hydropower and the thermal power installed generating capacity will be 3,380 MW, for a total of 4,690 MW. At that time, the peak load will exceed 6,000 MW and hydropower will have to bear

peaks of 1,300 to 1,500 MW most of the time. This will be hard for Fujian Province with an installed hydropower generating capacity of 5,550 MW. However, during average years thermal power will use about 8.6 million tons of coal, including 6 million-plus tons which will have to be shipped in from other provinces. Dry years will require burning about 13 million tons of coal including about 10 million tons which must be shipped in from other provinces. If coal source and transport difficulties have not been solved by that time, we will also have to develop even more hydropower (complete Jiemian Hydropower Station ahead of schedule, build a second group of medium scale hydropower stations, etc.) and do preparatory work to develop nuclear power.

### Hydropower Sources in Fujian and Their Development

40130127B Beijing SHUILI FADIAN [WATER POWER] in Chinese No 7, 12 Jul 89 pp 9-13

[Article by Shao Xuntong [6730 1789 6639] of the Fujian Provincial Electric Power Industry Bureau: "Characteristics of Fujian Province's Hydropower Resources and Issues of Development and Utilization"]

#### [Text] I. Status and Characteristics of Hydropower in the Energy Resource Structure

Fujian Province has a shortage of coal and no oil but is relatively rich in hydropower resources. Statistics show that hydropower accounts for 81 percent of Fujian Province's primary energy resource structure.

The results of a national energy resource survey show that Fujian Province has theoretical hydropower resource reserves of 10,460 MW and yearly power output of 91.6 billion kWh, with unit area hydropower reserves at 87 kW per square kilometer. It has about 1,000 sites with developable resources for a single station installed generating capacity of 500 kW and up for a total installed generating capacity of 7,050 kW and yearly power output of 32 billion kWh, equal to 46.5 percent of total hydropower resources in east China (excluding Taiwan Province). Fujian is the leader among the provinces of east China and holds 11th place (in yearly power output) for all of China's provinces (and autonomous regions).

In beginning with this basic situation, one inevitably reaches this understanding: to build a stable and reliable electricity source system, besides relying on long-distance transport of fuel to develop a specific amount of indispensable thermal power, the Fujian Provincial Grid must also make a major effort in the future to speed up hydropower development to meet the needs of the four modernizations drive. Here, I first will address some points concerning Fujian Province's hydropower resources:

1. The unit area amount of water produced in river basins is high and heads are concentrated.

Fujian Province has 597 rivers which cover basins larger than 50 square kilometers including eight which flow independently into the sea. Long-term average precipitation in the basins is 1,200 to 2,100 mm.

The river basin above the dam site at east China's largest conventional hydropower station now under construction, Min Jiang Shuikou Hydropower Station, covers an area of 62,400 square kilometers with yearly runoff of 54.5 billion cubic meters and unit area water production of 1.04 million cubic meters per square kilometer. However, water conservancy and hydropower projects including Wuqiang Xi on the Yuan Shui, Wujiangdu in Guizhou, Heyantan on the Hong Shui, Ertan on the Jinsha Jiang, Danjiangkou on the Han Jiang, Manwan on the Lancan Jiang, Fengman on the No 2 Songhua Jian, Liujia Gorge on the Huang He, and Panjiakou on the Luan He which have been built or are now under construction have unit area water production amounts of, respectively, 770,000, 690,000, 520,000, 450,000, 410,000, 360,000, 320,000, 160,000, and 74,000 cubic meters per square kilometer. Thus, it is apparent that Fujian Province's river basins have obvious advantages in a basic hydropower factor, "unit area water production in a river basin."

Fujian Province's rivers are short, have many shoals, flow fiercely, and have many gorges as well as relatively concentrated heads. For example, Gutian Xi, a first cascade tributary in full basin cascade development of the Min Jiang which has been achieved has a river channel just 123 kilometers long and utilizes a head of 317 meters. Not-yet-developed Muyang Xi in east Fujian has a river channel 105 kilometers long and a natural head of 850 meters. The Ding Jiang [as published] in west Fujian which has not been developed has a total river channel length of 285 kilometers and a natural head of 1,060 meters.

2. The amount of water arriving naturally in rivers is unevenly distributed across and within years.

Usually, the amount of water flowing in Fujian's rivers during wet years is three times that in dry years. The amount of water arriving is unevenly distributed across years as well as very unevenly distributed within a year's time sequence. The average amount of water arriving during the 4-month wet season (April to July) accounts for about 64 percent of the annual total whereas the amount of water arriving during the 8-month-long non-wet season (August to March) is just 36 percent of the annual total. This is particularly true of the 2-month-long main wet season in May and June, when the amount of water arriving can account for 42 percent of the yearly total, whereas the amount of water arriving during the 4-month dry season is just 13 percent of the yearly total. Reflected in hydropower characteristics, there is great instability across and within years and the amplitude of variations in output is particularly great between the wet and dry seasons. This is an issue which

cannot be ignored in research to determine how to fully and rationally utilize Fujian's abundant and cheap hydropower resources.

3. Relative inundation losses to obtain a unit amount of electric power are rather small and absolute losses for most medium scale power source sites are also very small.

Fujian has a population of about 28 million and a per capita cultivated land area of just 0.75 mu per person. Problems with inundation of cultivated land and population resettlement in reservoir regions are a factor which restricts accelerated development of Fujian's rich hydropower resources. However, in looking at the east China region with its relative shortage of energy resources, the relative amount of flooding per 1 million kWh of power obtained in Fujian is the lowest for all the provinces of east China. Min Jiang Shuikou Hydropower Station will have an installed generating capacity of 1,400 MW and generate 4.95 billion kWh of power annually. It will require flooding 39,000 mu of cultivated land and resettling 64,000 people, which are rather large values in absolute terms. For Fujian Province, which traditionally has been called an area which is "eight-tenths mountains, one-tenth water, and one-tenth fields," considerable problems were involved in relocating a large group of resettled people unwilling to move to new residences, providing cultivated land, and other things due to the flooding, but relative inundation losses per 1 million kWh for Shuikou Power Station were just 6.6 mu per 1 million kWh and 12.8 people per 1 million kWh. In contrast, the relative inundation values per 1 million kWh for three projects involving backbone hydropower stations on the Xin'an Jiang and Fuchun Jiang in the East China Grid and at Jinshuitan where construction began in 1988 were, respectively, 166.6 mu and 163.9 people, 63.5 mu and 50.9 people, and 34.4 mu and 44.4 people.

The total installed generating capacity at the five hydropower stations already built or to be built on the Ou Jiang in south Zhejiang Province, which is second only to Fujian Province in hydropower resources, is 1,360 MW, with yearly power output of 3.06 billion kWh. The relative inundation indices per 1 million kWh were 23.3 mu and 44.7 people. The seven medium scale hydropower stations (Qinshan-Zhouning, Wan'an, Shuidong, Mowu, Kongtou, Gaosha, and Huanglanqiao) planned for development in the near term in east Fujian, west Fujian, and tributaries of the Min Jiang in Fujian Province will have a total installed generating capacity of 570 MW and generate 1.78 billion kWh of power annually. Obtaining each 1 million kWh of power only required flooding 4.9 mu of cultivated land and resettling 2.8 people per 1 million kWh of power. Among them, Zhouning-Qinshan Power Station in east Fujian will have an installed generating capacity of 320 MW and produce 810 million kWh of power annually. A total of 1,458 mu of cultivated land was flooded and 1,254

people resettled. Both the inundation per 1 million kWh of power and the absolute inundation values were extremely small.

4. The proportion of medium scale hydropower resources is rather large, but the development rate is low.

The planned total installed generating capacity for China's medium scale hydropower stations with a single station installed generating capacity of 25 to 250 MW is 67,000 MW, with yearly power output of 320 billion kWh. This is just 16.8 percent of total developable resources (calculated according to power output). The planned total installed generating capacity of medium scale hydropower resources in Fujian Province, however, is 2,700 MW and yearly power output is 12.6 billion kWh, about 38 percent of total resources in Fujian. Most of these resources have not been developed. Only 5,890 MW has been completed and placed into operation so far, a development rate of just 22 percent.

5. Superior engineering conditions, simple development technologies.

The engineering conditions of undeveloped hydropower resource sites in Fujian Province are rather superior and construction of this group of hydropower stations only requires conventional hydraulic engineering technologies. There are no special scientific or technical problems. Most undeveloped hydropower stations are located in regions of igneous and metamorphic rock and are not in strong earthquake zones. Neither river bed dissection nor capping are deep and geological structures are generally relatively simple. Excluding some projects with maximum dam heights in excess of 100 meters, most dam heights do not exceed the already constructed Anshan Hydropower Station (92 meters). With the exception of an extremely small number of projects, the

length and diameter of water diversion tunnels do not exceed those at the already built Gutian Xi Second Cascade Hydropower Station. Construction of diversion facilities is far less difficult than Shuikou Hydropower Station now under construction. These superior engineering conditions are relatively important basic conditions for the rapid development of several hydropower stations with good quality, low cost, short construction schedules, and high benefits.

## II. A Review and Look Forward in Hydropower Construction

The total installed generating capacity in Fujian Province shortly after the nation was founded was only 900 kW. After nearly 40 years of hard and unrelenting effort, the total installed generating capacity of all types of hydropower stations completed in Fujian Province by the end of 1988 was 1,871 MW, with yearly power output of 6.72 billion kWh. This includes 1,486 MW at hydropower stations with a single station installed generating capacity of more than 500 kW, equal to 21 percent of developable hydropower resources. Since implementation of the principle of "reform and opening up," Fujian Province has made substantial progress in developing hydropower. The capacity of hydropower stations now under construction is 1,856 MW, almost as much as the sum of the accumulated hydropower capacity placed into operation over the past half-century. The capacity of large and medium scale hydropower stations where construction began since 1982 alone is 1,636 MW. Completion of these hydropower stations required excavation of about 1,400 cubic meters [as published] of earth and stone and pouring 4.7 million cubic meters of concrete. Table 1 lists the hydropower capacity placed into operation or under construction in Fujian Province.

**Table 1. Hydropower Capacity in Operation and Under Construction in Fujian Province at the End of 1988**

Capacity already in operation (10,000 kW)					Capacity under construction (10,000 kW)				
Scale of single station installed generating capacity					Scale of single station installed generating capacity				
>25	25-2.5	<2.5-0.05	<0.05	Total	>25	25-2.5	<2.5-0.05	<0.05	Total
15.0	58.9	74.7	38.5	187.1	155.0	8.6	15.6	6.4	185.6

Note: The capacity under construction for a single station scale of <5,000 kW is an approximate figure. The capacity under construction is the total installed generating capacity of the power stations minus the capacity of generating units already placed into operation.

Fujian Province has made obvious achievements in hydropower construction since the nation was founded. The total amount of power generated by hydropower is 64.6 billion kWh, about 64.5 percent of the power generated in Fujian over the same period. This is equivalent to a savings of about 45 million tons of raw coal. It has played an extremely important role in promoting development of the national economy in Fujian Province, which has extreme shortages of mineral and fuel resources and sea channel shipping lines which remained closed for a relatively long period of time. A review of history shows that the movement from small to large scale and from domestic management to international

bidding for hydropower construction in Fujian Province has progressed smoothly albeit on a winding path.

In 1951 soon after the nation was founded, there was a great deal of destruction that awaited rebuilding. The gross value of industrial and agricultural output in Fujian Province was less than 1 billion yuan. Policy-making levels at the time tried hard to develop Fujian's hydropower resources and correctly decided to build the Gutian Xi First Cascade Power Station. In the First 5-Year Plan, forces were concentrated to build the Gutian Xi First Cascade Power Station. Construction of cascade power stations on Gutian Xi continued through the Second 5-Year Plan. The Gutian First Cascade

Power Station, reservoir, and four subsequent cascade hydropower stations (with a total installed generating capacity of 259 MW) built during the 1950's continue to play roles as primary regulation reservoirs and primary hydropower stations in the Fujian Grid even today.

Construction begun during the "Great Leap Forward" period required flooding 600,000 mu of cultivated land and resettling 300,000 people, moved to build the Jian Xi Anfengqiao Hydropower Station (installed generating capacity of 1,000 MW) in two large county seats, and construction got under way at Mianhuatan Power Station on the Ting Jiang. The "Great Leap Forward" movement brought a "major step upward" "rising from a false fire" for hydropower in Fujian Province and the failure of the guiding theorists also created a "major step downward" for hydropower construction in Fujian. Work on both the Anfengqiao and Mianhuatan Hydropower Stations was halted. This created chaos in hydropower construction in Fujian and affected normal development, and it wasted an enormous amount of funds, with nearly 100 million yuan in capital for the single Anfengqiao Hydropower Station project alone being wasted.

During the Third 5-Year Plan, construction began on two projects with rather large reservoir capacities and rather good regulation capabilities. One was the Shanmei Water Conservancy and Hydropower Project on the Qin Jiang in south Fujian (installed generating capacity 30 MW). The other was Ansha Hydropower Station in the upper reaches of the Sha Xi, a tributary of the Min Jiang (installed generating capacity 115 MW). During the Fourth 5-Year Plan, construction also began at Hua'an Hydropower Station in south Fujian (installed generating capacity 60 MW) and Chitan Hydropower Station on the Jin Xi, a tributary of the Min Jiang (installed generating capacity 100 MW). The effects of interference by the "Cultural Revolution" during the Third and Fourth 5-Year Plans caused a slowdown in the pace of hydropower development in Fujian.

During the Fifth 5-Year Plan, erroneous decisions and real problems with financial capabilities by Fujian Province's policymaking departments regarding energy resource and electric power construction meant that no arrangements were made to start building large and medium scale hydropower projects during this 5-year period. This caused stagnation in hydropower resource development in Fujian and meant that no thermal power generators or large and medium scale hydropower station generators went into operation between October 1980 and October 1984 in Fujian Province. The contradiction between electric power supply and demand in Fujian intensified and power shortages appeared.

After implementation of the principle of "reform and opening up" in the Fifth 5-Year Plan, work got under way early in the Sixth 5-Year Plan to build Fujian's first large hydropower station, Shaxikou Hydropower Station on the Min Jiang. This is mainly a power generation

project but it also provides water-borne transport benefits. The power station has an installed generating capacity of 300 MW and generates 960 million kWh of power annually. Shaxikou Hydropower Station is the first electric power project in Fujian built in part using foreign investments. Kuwait's Arab Development Fund Commission provided some long-term preferential loans for this hydropower station.

In March 1987, construction began on the main project at Shuikou Hydropower Station on the Min Jiang, one of China's key capital construction projects during the Seventh 5-Year Plan. Construction of Shuikou Hydropower Station (as well as Fancuo and other medium scale hydropower stations built with capital raised by departments during this period) indicates that Fujian's hydropower industry has entered a new stage. Shuikou Hydropower Station, which is focused on power generation but also provides benefits from development of water-borne transport on the Min Jiang, will have an installed generating capacity of 1,400 MW and produce 4.95 billion kWh of power annually. This power station is the only conventional hydropower power source site in east China with an installed generating capacity over 1,000 MW and it is one of China's biggest conventional scale energy resource projects built in part with a loan from the World Bank (IBRD). It is also China's first large scale hydropower station project which implemented international competitive bidding for the entire civil engineering project.

After implementation of the principle of raising capital to develop power in China, a new situation of raising funds from many channels to develop medium scale hydropower appeared in Fujian Province. In December 1984, the Fujian Provincial Government provided specific preferential policies to encourage a start of construction at Fancuo Hydropower Station on the Jin Xi, China's first medium hydropower station built using funds raised through joint shares by departments themselves. This power station has an installed generating capacity of 36 MW. The investment was raised through 50, 35, and 15 percent shares respectively, from the Fujian Provincial Electric Power Bureau, Jiangle County Government, and Min Jiang Hydropower Engineering Bureau. The power station was built by implementing a company responsibility system under leadership of a board of directors and will be included in the Fujian Provincial Grid System after it is completed for unified management and dispatching. The parties who raised the capital will have power use rights and profits and specific property rights according to the proportion of their shares. Subsequently, capital raised by departments also served as the basis for starting construction at Dehua Longmentan Cascade Power Station in central Fujian (installed generating capacity 44 MW) and Liangqian Power Station at Taining on the Jin Xi (installed generating capacity 30 MW) which were subsidized by a small amount of low interest loans provided by the state. Practice has proven that Fujian has taken a gratifying

first step on the road to exploring primary reliance on departmental capital raising to develop medium scale hydropower resources.

Small scale hydropower (with a single station installed generating capacity of 500 kW to 25 MW) and rural small scale hydropower (with a single station installed generating capacity under 500 kW) is another important component of hydropower resource development and utilization in Fujian. The planned total installed generating capacity of small scale hydropower resources is 1,790 MW, with yearly power output of 10.7 billion kWh, equal to about one-third of total hydropower resources in Fujian Province. Fujian has widely distributed rural small scale hydropower resources. Relevant departments estimate a total of about 10,000 sites, with a total installed generating capacity of 1,000 MW and yearly power output of about 3 billion kWh. In 1988, the small scale hydropower and rural small scale hydropower installed generating capacity in Fujian totaled 1,132 MW. They have played a substantially important role in meeting the power use needs of regions not yet connected to grids and in a substantial proportion of township and town enterprises, illumination, agriculture, and so on within grids. Ten counties in Fujian Province, Guangze, Longxi, Yongchun, Mingqing, Yong'an, Liancheng, Nanqing, Bingnan, Jian'ou, and Denhua counties, have been included among China's rural electrification pilot project counties and the first five counties have passed examination and acceptance as having attained the standards of preliminary electrification counties. Major efforts to develop small scale hydropower and rural small scale hydropower has laid an important foundation for achieving rural electrification in these counties.

In looking toward the future, projections are that Fujian Province will require an additional 29.5 billion kWh of power over the 13-year period between 1988 and 2000 (including some power transmitted to the East China Grid by Shuikou Power Station), which will require adding 7,600 MW in installed generating capacity. Plans call for a power output ratio of 45:55 between hydropower and thermal power at the end of this century, so 3,600 MW in installed hydropower generating capacity must be added over 13 years. Besides Shaxikou (300 MW) and Shuikou (1,400 MW) Hydropower Stations now under construction on the Min Jiang, Fujian also must focus on developing medium and small scale hydropower resource sites with a total installed generating capacity of about 1,000 MW as well as Zhouning-Qinshan (320 MW) and Ting Jiang Mianhuatan (600 MW) Hydropower Stations, and other backbone power sources. Some large and medium scale hydropower stations planned for development before the end of this century include Mianhuatan (600 MW), Qinshan (70 MW), Zhouning (250 MW), Wan'an (45 MW), Shuidong (76 MW), Kongtou (39 MW), Mowu (30 MW), Gongchuan (32 MW), Shaxian (38 MW), Gaosha (50 MW), Xiayang (39 MW), Huanglanqiao (30 MW), Bailai (50 MW), and Jinshan (30 MW).

Looking forward to the period 2001 to 2015, a total of 13,000 MW in installed generating capacity must be added over 15 years. Tentative plans call for a 24:61:15 ratio for hydropower, thermal power, and nuclear power, respectively, for Fujian's power source structure in the year 2015, so the additional installed generating capacity for hydropower would be 2,000 MW. Looking forward to this period, subsequently to be developed are primary hydropower stations to be built including the You Xi Jiemian (400 MW) and other cascade power stations as well as medium scale power source sites on the Jian Xi, Dazhang Xi, Huotong Xi, Ao Jiang, and other rivers.

### III. Some Issues Deserving Attention

In analyzing the hydropower resource development and utilization situation in Fujian Province, I feel that these questions deserve attention:

1. Fully acknowledge the strategic status of hydropower in the electric power and energy resource industries and truly implement the principle of "striving to the greatest possible extent to develop hydropower in regions with hydropower resources and increase renewable energy resources" when formulating electric power development plans and policies. A major effort to accelerate hydropower resource development in Fujian Province is necessary not only because of obvious advantages in the structure of energy resources in Fujian since greater hydropower resource development and utilization is not restricted by construction scale, production capacity, and transportation conditions for coal and other mineral fuels. It also is necessary because the cost of generating power via hydropower is far less than the cost of generating power via thermal power. Whether one is speaking of the microeconomic benefits for electric power users or macro benefits for local finances, there are advantages to developing more hydropower. Cost analyses of power generation for six hydropower stations and six thermal power plants in the Fujian Grid over the past 10 years show that they rose from 0.00646 yuan/kWh to 0.01138 yuan/kWh. This figure increased from 0.04462 yuan/kWh to 0.06613 yuan/kWh for thermal power under conditions of burning mainly Fujian's own coal transported over short distances. The cost of power generation for hydropower is just 15 to 17 percent of that for thermal power. Given that the discrepancy between the value of coal and its price in China will be further straightened out and the fact that coal used for new thermal power construction in Fujian must be shipped in over great distances from other provinces and other factors, the differential between hydro and thermal power generation costs will continue to expand. Utmost efforts to develop more hydropower also depend on formulation of a relatively stable and foresighted electric power and energy resource development plan. Under guidance by this plan, our determination to develop more hydropower should not be shaken if we encounter dry years or have certain funding difficulties. We cannot neglect developing the necessary thermal power because of the interchangeability of hydropower and thermal

power if we encounter a wet year or have certain problems with coal supplies. We cannot neglect the importance of major efforts to develop large and medium scale hydropower because of the excellent situation of small scale hydropower development by the masses by feverishly thinking that "small scale hydropower is the most important power source for Fujian's electric power industry." We cannot forget the obvious advantages and potential of medium scale hydropower resources in Fujian because we build large scale hydropower stations.

2. To accelerate the development of medium scale hydropower resources, we should formulate policies to support medium scale hydropower. Fujian's advantages in medium scale hydropower lie not just in their relative abundance, broad distribution, and superior technical and economic indices. They also lie in the fact that the requisition of land and population resettlement can be handled locally and that they are characterized by small investments, short construction schedules, and rapid benefits. Moreover, during a period of implementing a planned commodity economy and raising capital to develop power, raising construction funds for medium scale power stations conforms more to the wishes of those raising the funds than do large scale power stations, so they are more conducive to motivating initiative to invest in all areas. At the same time, it should be noted that whether or not the state and local governments provide policy assistance for medium scale hydropower development has an extremely important influence on the enthusiasm of those raising capital and on the scale and speed of development. As embodied in the raising of capital by departments to develop medium scale hydropower in Fujian, policy measures to support the development of medium scale hydropower should include the following aspects: 1) To assure that power is allocated in proportion to the shares of those raising the capital, government departments which administer electric power allocation should not encroach upon or covertly equalize power use rights of those who raise the capital. 2) In beginning with the macro perspective of energy resource development strategies and absorbing social capital to develop power, the necessary preferential policies should be provided in taxation. They should be exempt from requisition of product taxes for at least 3 years after going into operation and afterwards the 5 percent product tax should be collected according to "small scale electric power." Pre-tax loan repayment should be exempted from collection of income taxes for the period of loan repayment. 3) During the period of principal and interest repayment (10 to 12 years) after a power station goes into operation, the electric power generated should be treated as power supplied outside of plans and floating electricity prices implemented. 4) The development of hydropower resources falls under "multiple uses of a single water source" and it should be exempt from collection of land occupation taxes. 5) Power station ownership rights and administration rights should be strictly separated, and past "bureaucratically run" power stations should be changed into power

stations under administrative management by entrepreneurs to increase the economic benefits of the power stations themselves. Implement unified dispatching of power stations after they are completed to raise safety levels and improve economic results.

3. Fujian Province's hydropower resources are relatively abundant compared to the East China Grid and Fujian's neighboring provinces and there is very great development potential. How to begin with an even larger scope to study full and rational utilization of Fujian's hydropower and take advantage of its dynamic benefits is a major topic in the development and utilization of Fujian's hydropower resources. For example, the installed generating capacity in the East China Grid will be almost 20,000 MW with yearly power output of nearly 100 billion kWh. The "peak-to-valley differential" in the daily electric power load is about one-third of the maximum load, whereas the ideal peak regulation capacity including hydropower is very small, which causes the appearance of low cycles at times of peak load in the grid and high cycles at times of valleys. This is somewhat unfavorable to safe and economic operation and power quality. Now and in the long-term, the East China Grid urgently requires a substantial increase in hydropower capacity to compensate for the serious inadequacy in system peak regulation capacity. Actually, however, the proportion of hydropower in the grid will decline from the present 13 percent to 7 to 8 percent in 1995. For current hydropower development and utilization in Fujian Province, with the exception of considering having Shuikou Hydropower Station bear partial peak regulation tasks in the East China Grid, almost none of Fujian's hydropower development and utilization plans and designs (parametric value selection including choice of installed generating capacity and plans for pumped storage power stations) consider issues of Fujian's hydropower in regard to the urgent need for peak regulation capacity in other provinces and gaining greater benefits in regions having a very large proportion of thermal power and expensive fuels. One problem involved in solving this question is the difficulty in raising the increased initial construction funds needed to take greater advantage of the benefits of hydropower in Fujian. For this reason, I propose that comprehensive management departments under jurisdiction of the Ministry of Energy Resources look into and study this issue.

#### **Hubei Focuses on Developing Its Hydropower Resources**

906B0022A Beijing RENMIN RIBAO in Chinese  
5 Sep 89

[Excerpts] [Passage omitted] In Hubei, through which the Chiang Jiang and Han Shui flow, large and small rivers intersect. According to surveys there are 38 million kilowatts of hydropower resources which can be developed and exploited province-wide for 140 billion kilowatt-hours of electricity yearly. This is equivalent to

60 million tons of standard coal. For coal-short Hubei, this is an abundant natural endowment. [passage omitted]

The Gezhouba key water conservancy project was completed in 1988. Its 21 generating units with an installed capacity of 2.715 million kilowatts have all come on line. During the past 40 years, the province has built 230 hydropower stations of over 500 kilowatts, for an installed capacity of 4.3318 million kilowatts and an annual power generation of 20.734 billion kilowatt-hours. These are records for all provinces and municipalities across the country. Prior to this, from 1958 to 1987, Hubei built the Fanjiangkou key water conservancy project. Called the "pearl of the Han Shui" it has an installed capacity of 900,000 kilowatts. Apart from the Huanglongtan, Fushui, Bailianhe and Lushui medium-sized hydropower stations, by the end of 1988, throughout the province 2,659 small hydropower stations had been built with a total installed capacity of 750,000 kilowatts. In 1987, Hubei began work on the 1.2 million-kilowatt installed capacity Qingjiang Geheyan hydropower station. Hubei is also developing thermal power. Over the past 40 years, 42 thermal power plants of over 500 kilowatts, such as the Huangshi, the Wuchang, the Qingshan, the Jingmen and the Shashi power plants have been built one after another at the center of load in eastern Hubei. The installed capacity is 1.920 million kilowatts. In 1987, construction was begun

on the 1.2 million-kilowatt installed capacity Hanchuan power plant which it is hoped will improve the weak power grid structure.

Present-day Hubei has the country's largest hydroelectric base, the country's largest substation and the country's first 500,000-volt super-high tension alternating current power transmission line. The rural power grid coverage has exceeded 84 percent. Per capita power usage province-wide is over 500 kilowatt-hours, 150 times that prior to the revolution. [passage omitted]

#### **Guangzhou Pumped-Storage Station To Start Construction in 1990**

*40130011c Guangzhou NANFANG RIBAO in Chinese  
24 Dec 89 p 1*

[Summary] Preparatory work has been completed on the Guangzhou pumped-storage hydroelectric power station, the largest project of its kind in China and listed by the State Council as one of the key new projects for 1989. Full-scale construction is slated to begin in 1990. The power station, which is being built with a mixed loan of \$200 million from the French government, as well as equipment provided by France, will have a total installed capacity of 1.2 million kW. Upon completion, the power station will greatly increase the safety of nuclear power stations, and will also greatly enhance peak current regulation capabilities of the grid, as it means an additional 2.3 billion kilowatt-hours of peak current annually.

### Coal as Backbone of Energy Development Strategy

40130132A Beijing JINGJI RIBAO in Chinese  
9 Aug 89 p 2

[Article by Huang Yicheng [7806 3015 6134]: "We Should Consider an Energy Resource Strategy Based on Coal"]

[Text] Which of the primary energy resources on China's vast territory can be considered to be our advantages? From the perspective of reserves on hand, we cannot feel that we have a great deal of petroleum, natural gas, iron ore, nonferrous metals, land, forests and so on, and per capita amounts are even smaller. Our only relatively abundant energy resources are coal and hydropower. We have proven coal reserves in excess of 800 billion tons and prospective reserves of several trillion tons, so it can be said that China is one of the world's richest nations in coal reserves.

Taking full advantage of our coal resources is very important for transforming China's energy resource shortage situation, so we must consider the coal's primary status in the overall energy resource strategy.

At present, there are many conditions conducive to taking advantage of our coal resources. For example, we have our own capacity for technical development with the modern coal extraction technologies we already have, both in shaft mining and open cut mining. We can already manufacture modern coal extraction equipment. Although it cannot be said that we are among the world's best, we do have a relative level and basically can satisfy domestic production and construction needs. Moreover, the development of rural production capacity has enabled considerable labor power to move into coal mining, and their wage levels can be considered the lowest among the world's similar industries. Thus, coal prices are strongly competitive.

Of course, there are also disadvantageous conditions. The main ones are: 1) Insufficient capital to develop coal. The state invests under 10 billion yuan annually to develop coal and rising materials prices mean that actual investments have fallen. The financial strength of local areas and enterprises is slightly stronger in relative terms, but their enthusiasm for investing to develop coal is limited. Coal producing enterprises are even less able to invest in their own development because they are operating at a loss. The number of capital construction and new development projects for coal has dropped in the past few years and our reserve strengths are inadequate. Insufficient capital is the main cause. 2) Transport is difficult and coal cannot be shipped out. China's coal resources are located mostly in west and north China. The "three west" region (Shanxi, Shaanxi, and west Inner Mongolia) are the largest coal base areas we are now developing. However, southeast China has our most developed industry, greatest population concentrations, and largest amount of coal consumption. The distance by railway between the "three west" and the

southeast coastal is more than 1,000 or 2,000 kilometers, and some must even be shipped by a combination of rail and sea. China's inadequate railway transport capacity makes it very hard for it to bear the great pressure of shipping out an additional several 10 million tons of coal each year. 3) Our domestic demand for coal has grown too quickly. The growth rate for industry as a whole is too high, and this is particularly true for the overly rapid development of the processing industry, which consumes considerable amounts of energy. They need coal and power, and power is actually coal, but growth in coal lags far behind industrial demand.

To deal with these unfavorable situations, implementation of an energy resource strategy focused on coal still requires us to adopt new methods.

First, we should raise capital from more areas and increase inputs in coal. Investments in the coal industry from state financial resources each year should increase along with rises in materials prices. Deregulate electric power industry methods and requisition a coal construction fund which requires payment by coal users. Raise the price per ton of coal or increase the price of power used by 0.01 yuan per kWh for a coal mine construction fund. Use foreign capital and stipulate that all foreign exchange earned from future coal exports be used to repay foreign investments in coal. Shorten mine construction schedules and use existing funds well.

Second, use multiple channels to solve transportation problems. There should be a major effort to develop pit mouth power stations and implement joint administration of coal and power to shift from transporting coal to transmitting electricity and free up transport capacity to ship coal out for export. Make a firm decision to build a large railway coal transport channel with an annual transport capacity of over 100 million tons from the Dongsheng-Shenfu area to sea ports. Reinforce transformation of existing railroads. Construct pipeline coal transport trunklines.

Third, adopt various measures focused on energy conservation. The efficiency of energy resource utilization in China is very low at the present time and there is great potential for energy conservation. Besides adopting resolute measures to close down and stop production at enterprises which consume large amounts of energy and have poor results, there are many ways to conserve energy in the energy resource industry itself. For example, reducing the average amount of coal consumed for power generation for all of China's thermal power generators from the present figure of 435 grams/kWh to 352 grams/kWh by the year 2000 could save about 83 million tons of standard coal annually, equivalent to 116 million tons of raw coal. With additional transformation for heat-power cogeneration at existing 400,000-ton and 800,000-ton/hour industrial and heating boilers and a major effort to develop gangue power stations at coal mines, adoption of these three energy conservation measures could save an estimated 150 million tons of raw

coal annually when they are implemented, so the economic benefits are extremely substantial.

Coal is now China's main primary energy resource and electric power is the main secondary energy resource, but 70 percent of our electric power comes from coal. Thus, in a certain sense, solving China's coal resource problem is mainly a question of dealing with coal. The preceding analysis indicates that merely by relying on reforms, relying on correct economic and technical policies, raising capital from multiple sources, dealing with transport problems through many channels, and adopting many different measures for energy conservation, we can make coal supplies meet the needs of normal growth of the national economy and increase exports, which would truly take advantage of our coal energy resources.

#### **Jungar: Coal Construction Front Moves West**

906B0023A Beijing RENMIN RIBAO in Chinese  
20 Oct 89 p 2

[Excerpts] The curtain has risen on coal field construction in Jungar, Inner Mongolia, signaling a strategic movement of coal field development in China from east to west. Many new buildings have appeared on the Eerduosi plateau. A 120-kilometer highway leading to Huhezaote has been built. A 10,000-ton per day water source has begun to supply water and a 200,000-volt high tension electric line is under accelerated construction.

The Jungar coal field is one of China's modern open-pit mines. It is located in the eastern part of the Jungar Banner in the Inner Mongolia Autonomous Region. A 1,022-square-kilometer coal field has been explored with reserves of 27.2 billion tons. Extraction is easy and the coal quality is excellent. Its establishment will play a major role in making the national economy prosperous and in alleviating the energy shortage in the northeast and north China regions. [passage omitted] The design capacity of the project's first phase, which will formally begin next year, is 12 million tons. Also under construction is a 200,000-kilowatt installed capacity power plant and a 215-kilometer electrified railway. [passage omitted]

#### **Shanxi Shipping More Coal**

40130132C Taiyuan SHANXI RIBAO in Chinese  
4 Aug 89 p 2

[Article by Tong Wenyi [0104 2429 5669]: "A Substantial Increase in the Amount of Coal Shipped by Datong Railroad Branch Bureau, Rely on Science and Technology, Accelerate Shipments of Coal From Shanxi"]

[Text] The Datong Railroad Branch Bureau, which ships one-eighth of all coal by China's railroads and 50 percent of the coal shipped from Shanxi and is the leader of China's 56 railroad branch bureaus, has resolutely relied on scientific and technical progress to complete its coal transport tasks which have become continually heavier

in excess of quotas year after year and made a prominent contribution to the four modernizations drive.

The amount of coal shipped by the Datong Railroad Branch Bureau has grown at an average yearly rate of 12 percent. To complete the coal transport tasks assigned by the state which have risen substantially, they broadly applied advanced science and technology and adopted many types of measures to exploit potential and expand capacity. The big Fengsha electrified railway was opened to traffic in 1985 and the Datong Railroad Branch Bureau boldly carried out research experiments on single locomotive pulling of 3,700 tons which were instantly successful, exceeding the design capacity by 400 tons. Later, through analysis and calculations, they were successful in two experiments using a single locomotive to pull 4,000 tons, exceeding the design capacity by 700 tons. They can ship an additional 5.42 million tons of freight each year, conserve 25.3 locomotives, and increase their income by 30.57 million yuan, equivalent to reducing state investments in fixed assets by 41.125 million yuan. They had a joint venture with the Beijing-Datong-Pukou line and local areas to build nine dedicated lines for full car loading, and changed from decentralized loading to centralized full car loading, which reduced loaded car pulling activities and raised car loading efficiency. Decentralized loading of a single car used to take 12 hours but now it takes only 2.5 hours. This item alone enables them to ship an additional 1.3 million-plus tons of coal each year.

Continual application of new technologies and new equipment has brought greater stability in safety at the Datong Railroad Branch Bureau and productivity has risen continually. The Dongtong-Zhangjiakou section shipped 39 million tons of freight in 1980 and the figure rose to 82 million tons in 1988. Shanxi Province's three railway branch bureaus lead in 13 of 15 main economic and technical indicators. They lead the Beijing Railway Bureau in nine items, and they are the leader among China's 56 railway branch bureaus in six items. They achieved 1,000 days of safe production through 5 July 1989.

#### **Update on Progress at Shenfu Dongsheng Fields**

906B0023C Beijing RENMIN RIBAO OVERSEAS  
EDITION in Chinese 28 Oct 89 p 1

[Excerpt] China's largest power coal base—the Shenfu Dongsheng coal field—is now under accelerated development and construction. After several years' efforts, the field's first phase of development has made a great deal of progress.

The Shenfu Dongsheng coal field is located at the intersection of the borders of Shaanxi Province and the Inner Mongolia Autonomous Region. The area of this coal field is 25,500 square kilometers and it contains over 230 billion tons of low ash, low sulfur, mid-to-high caloric capacity power coal of superior quality.

According to the mining district overall plan, ratified by the state, coal field development is divided into three stages: From 1986 to 1992, the scale of coal field construction is to be 12 million tons per year and outward transport of coal is to be 10 million tons per year. By 1995, production of coal for outward transport will be 30 million tons per year and by the year 2000, production will reach 60 million tons annually with outward coal transport of 45 million tons per year. If the above development objectives are to be realized, a total of 1,100 kilometers of railroads dedicated for coal use must be built, along with 500 kilometers of mining district highway, and coal mines on a 60 million-ton scale, a 1.2 million-kilowatt power plant and one 35 million-ton port. Also, appropriate complementary facilities and coal dressing projects must be built.

The 172-kilometer railroad from Baotou to Shenmu began trial operations this March and it is estimated that the entire Bao-Shen railroad will be completed by the end of this year. The 303-kilometer main highway from Baotou through the mining district to Fugu will be completed next year. The Shenmu power plant will be completed and generate power this year. The mining district's 110,000-volt light electric lines have begun to transmit electricity. The coal mine has begun work on 12 pairs of key mine pits. This year there will be mines entering production one after another.

Foreign capital will be used for construction of the railroad from Shenmu through Shuoxian to the new port, the port itself and the Fugu 2 x 350,000-kilowatt power plant. This is to be repaid with the superior quality power coal of Shenfu Dongsheng. [passage omitted]

**Ambitious Plan for Oil Production Unveiled**

40100026 Beijing CHINA DAILY in English  
19 Jan 90 p 1

[Article by Li Hong]

[Text] An ambitious programme to speed up exploration and production of offshore oil and gas—within the Eighth Five-Year Plan (1991-95) period—has been worked out by China's energy planning board, CHINA DAILY has learned.

"The success of this programme will help to ease the country's continuous energy shortage," according to a leading industry official.

The guiding principle in the programme is "to intensify China's cooperation with foreign consortiums, while reinforcing our own capacity in offshore prospecting and drilling," said Zhong Yiming, president of China's National Offshore Oil Corporation (CNOOC).

Zhong told CHINA DAILY in an interview yesterday that specific goals have been set for the country's offshore oil output in the next five years. The output this year will reach 1 million tons while 5 million tons of crude will be produced in 1992, 6 million in 1993, and the production capacity is expected to hit 8 million tons in 1995.

By 1995, more than 20 offshore oilfields will have been developed in the country's coastal areas, he said.

Last year, China's three offshore oilfields produced more than 900,000 tons of crude.

The president reiterated four deals his corporation will focus on in the years to come.

First of all, the corporation will stick to and carry out consistently those sealed contracts between CNOOC and foreign oil companies.

According to Zhong, to date \$2.22 billion of "risk exploration funds" and \$430 million of development funds have been invested by foreign consortiums, leading to the production of three offshore oilfields.

In conjunction with foreign firms, China is opening up four offshore oilfields and will soon move to another five newly-developed petroleum and gas fields, most of them located in the Pearl River estuary, south of Guangzhou.

These foreign consortiums have come from the United States, Japan, Britain, France, Italy and Norway.

During the current economic restructuring and retrenchment programme, China's offshore industry should try every way to overcome its difficulties, Zhong said.

Zhong said that his corporation and two other companies from Japan and the United States had entered into an agreement to investigate the possibility of a joint venture in the middle of this year.

**Progress Made in Oil Drilling Technology**

40100025A Beijing XINHUA in English 1244 GMT  
16 Jan 90

[Text] Beijing, January 16 (XINHUA)—Directional drilling and cluster oil wells are now common at the Liaohe, Shengli and Dagang oil fields, which made profits of 250 million yuan last year.

According to the Department of Science and Technology Development under the China National Petroleum Corporation, the drilling technology was one of the ten achievements China made in oil technology last year.

The adoption of this technology made it possible to drill dozens of oil wells in a small area without moving oil rigs.

Another achievement was the successful adoption of high-resolution seismic exploration, which enabled Chinese technicians to verify three medium-scale oil fields and control 300 square kilometers of structures last year.

A new gouge-type drill head, developed jointly by China Petroleum University and Shengli oil field, increased the drilling technology standard by more than 30 percent.

Other achievements have also been made in oil deposit numerical value simulation, energy economy, and evaluation of gas deposits.

Jiang Qikai, director of the Science and Technology Development Department, said China had tried to tap potentials and increase the profits of the oil industry by developing science and technology as it was facing a serious shortage of oil resources and funds.

Jiang believes these achievements will help produce more oil and gas from old oil fields and locate new oil and gas fields.

**Shengli Sets Well-Drilling Record**

40100025B Beijing XINHUA in English 1611 GMT  
22 Jan 90

[Text] Beijing, January 22 (XINHUA)—The successful drilling of 42 wells from one platform in Shengli oil field, east China, means that China has advanced the technology of directional multiple well drilling, the PEOPLE'S DAILY reports today.

The wells, with an average depth of 2,962 metres and an angle of 63.75 degrees, set a record in number at one drilling platform in China's well-drilling industry.

The project, one of the key tasks in the Seventh Five-Year Plan (1986-1990), was completed a year ahead of time by the China Oil and Natural Gas Corporation.

The technology makes possible well-drilling in extremely shallow seas, marshland, and oil and gas fields with complex land surfaces.

It will help to save funds and land, prevent pollution and increase the output of oil.

### **Eastern Junggar Fields Basically Finished, Ready for Production**

906B0024A Urumqi XINJIANG RIBAO in Chinese 17 Oct 89 p 1

[Excerpt] In the 4,200 square kilometer oil-bearing area in the eastern part of the Junggar Basin, seven large and small oil fields, one gas field, and seven points of oil emergence have been discovered. The Huoshaoshan oil field in Karamay is being developed.

As of late September, an accumulated oil production capacity of 1.15 million tons had been established at the Bei 16 and Bei 31 well area oil fields of Beisantai. It is estimated that by the end of the year, this could reach 1.40 million tons.

After several years of exploration, development, and oil field construction, a new-type petroleum production base is taking shape. Within the oil field, a 104-kilometer asphalt highway has been built. An underground oil pipeline extends from the Huoshaoshan oil field, connecting the Bei 16 and Bei 31 oil fields directly to the Beisantai oil depot. It is estimated that by year's end, the oil pipeline from the Beisantai oil depot to Wangjiagou will also be completed. By late September, 96 kilometers of pipeline had been welded and 94 kilometers of ditches excavated. [passage omitted]

### **Big Strides Claimed for Tarim Exploration**

906B0024B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 7 Nov 89 p 4

[Text] After 10 years of large-scale exploration, China's petroleum geology exploration workers have made a major breakthrough with regard to knowledge of the geological structure and oil producing patterns of the Tarim Basin.

Specialists explain that this new knowledge includes the discovery that in the Tarim Basin there exist large amounts of marine deposits, and that the thickness of its marine facies reaches 4,000 to 9,000 meters. Moreover, it is widely distributed, covering the entire basin. The potential for producing oil is enormous. A group of large and very large geological structures conducive to storing oil and gas have been located. Many oil-producing and oil-bearing layer systems have been discovered and they all have high-output characteristics.

The Tarim Basin is China's largest inland sedimentary basin with an area of 560,000 square kilometers. The Taklimakan Desert, at its center, has an area of 330,000 square kilometers and is China's largest desert. China's oil and gas exploration in the Tarim Basin has a 37-year history, during which there have been complications. According to traditional petroleum production theory, petroleum can only be formed in marine sedimentary layers. Prior to the 1950's, because it was not able to

discover large marine sedimentary basins, China was judged to be an oil-poor country.

However, China's petroleum departments, in accord with the continental facies petroleum production theory proposed by the geology community in China, successively discovered the large oil fields of Daqing and Shengli, overturning the "China as oil-poor" theory.

At the close of the 1970's, China's petroleum exploration workers introduced advanced desert exploration technology and equipment, and entered the desert to initiate exploration, thus gaining knowledge and assurance regarding the basin.

The discovery of marine sedimentary oil-producing layers in the Tarim Basin is undoubtedly another instance of a major breakthrough in knowledge. At the same time, it has also provided a new field for the development of China's petroleum industry.

Through exploration, China's petroleum workers discovered in the Tarim Basin a group of large to very large structural anticlinal traps exceeding 100 square kilometers in area. The largest of these, the Tazhong structure, covers 8,200 square kilometers. This is the largest geological structure China has discovered; it is over three times the size of the Daqing oil field geological structure.

Initially, there was concern that because the ground temperature of the Tarim Basin is high, its oil had become natural gas. However, during exploration it was discovered that for every 100 meters of depth, the basin's ground temperature only rose 1.7 to 1.9 degrees Celsius, less by nearly one-half than that of the oil fields of eastern China. Therefore, even though the oil layers are buried deeply, they are still rich in both oil and natural gas, not predominantly in natural gas. These new discoveries have made possible the location of large-scale or very large-scale oil and gas fields in the Tarim Basin.

Since 1977, when the Kegan number 1 well obtained a high output of oil and gas in the Tarim Basin, there have been over 10 wells which have obtained high oil and gas outputs. On 31 October of this year, the Tazhong number 1 well obtained a high output of oil and gas.

### **Another Central Tarim Exploration Breakthrough Reported**

906B0024C Guangzhou NANFANG RIBAO in Chinese 3 Nov 89 p 3

[Text] Petroleum exploration in the Tarim Basin, a focus of attention both in China and overseas, has made a major breakthrough. Spokesman for the China Petroleum and Natural Gas Company, Wu Zongying, announced at this morning's news conference that on 31 October, the Tazhong number 1 well located in a remote region of the Taklimakan desert obtained a high output oil and gas flow with a daily output of 576 cubic meters of crude oil and 360,000 cubic meters of natural gas.

The Tarim Basin's Tazhong structure, where the Tazhong number 1 well is located, in terms of area is China's largest oil-bearing structure. According to the most recent determination, the area of this anticline is 8,200 square kilometers. Since drilling began on the Tazhong number 1 well on 5 May of this year, a continuous 117-meter oil layer has been discovered. According to rock core analysis by experts, this oil layer has the capacity for high output. Today, drilling is continuing on this exploratory well.

The major breakthrough obtained by the Tazhong number 1 well is the fruition of the long-term work of China's petroleum personnel. After its establishment this April, the Tarim Petroleum Exploration and Development Headquarters made the Tazhong structure a key area of exploration. Analysis of a large amount of survey data indicates that the estimated petroleum reserve in

the Tarim Basin is 10.1 billion tons and natural gas reserves are 8.3 trillion cubic meters. These account respectively for one-seventh and one-fourth of the reserves of oil and gas nationwide. Wu Zongying said that the enormous potential oil and gas resources of the Tarim Basin early on attracted the attention of the petroleum community both domestically and overseas. During these years, a number of major achievements have been made in the basin's northern region through the joint efforts of petroleum and mining departments. This high-output oil and gas strike by the Tazhong number 1 well further confirms that the Tarim Basin holds abundant resources of oil and gas and has opened yet another front for the search for large-scale high-output oil and gas fields. This is of major strategic significance to the development of China's national economy.

### **Nation Focuses on Development of Solar Energy**

906B0025B Beijing RENMIN RIBAO OVERSEAS  
EDITION in Chinese 2 Nov 89 p 3

[Excerpt] Solar energy is beginning to be broadly utilized by the Chinese people and in each sector of social production. According to statistics, as of the end of 1988, China had built solar powered buildings and structures totaling 1 million square meters and solar powered water heaters of all types were being used in 1 million square meters. Solar battery generating units of 700,000 Watts have been installed and used, along with solar powered heaters of 11,000 square meters. A total of over 10,000 solar ovens are in use. The information provided by the "International Seminar on Developing Solar Power Utilization in the Chinese Home" indicates that China is one of the regions of the world most richly endowed with solar power resources. In recent years, with the assistance of the United Nations Development Planning Office and the UN Department of Technological Cooperation, major efforts to research, develop, demonstrate and promote all types of new energy sources have made encouraging progress. Gansu Province has exploited its particular geographic and climatic conditions to take the lead at a heartening pace in the area of solar power utilization. Throughout the province, solar ovens have grown to a total of 57,000 units. This accounts for half of the national total. Fifty-four thousand square meters of solar buildings have been built, accounting for one-third of the national total. Each year the energy supplied by solar power accounts for 1 percent of total power consumption throughout the province. Additionally, scientific research, experimentation, development and production bases centered around Lanzhou have taken shape along with a solar building demonstration base in southern Gansu, the Linxia and Dingxi solar oven demonstration bases, and the Dunhuang and Jiuquan integrated solar power application bases. [passage omitted]

### **Efforts To Develop Tidal Power Meet With Success**

906B0025A Beijing LIAOWANG [OUTLOOK]  
in Chinese 4 Dec 89 p 17

[Excerpts] On the shore of the East China Sea in Zhejiang Province, at the northern end of Leqing Bay, there is a major scientific experiment for opening up tidal resource exploitation in China. Although its total installed capacity is only 3,200 kilowatts, nevertheless, it ranks third in the world behind tidal power stations in France and Canada.

Jiangxia Gang's maximum tidal range is a surprising 8.39 meters. [passage omitted]

Over the past several years, the amount of electricity generated by the Jiangxia power station has increased each year. In 1987, there was a 340,000-kilowatt-hour increase over 1986; in 1988, there was an increase of 110,000 kilowatt-hours compared to 1987. This year, 6.20 million kilowatt-hours will be reached. From the

completion of the Jiangxia power station at the end of 1985 until this September, there was an accumulated generation of power of over 30.02 million kilowatt-hours. [passage omitted]

The Jiangxia power station is a new-type power station which China relied on its own capability to design, and the equipment for which was all independently manufactured. An appraisal by specialists considered that its significance indicates that it is already close to the international level represented by France's Rance tidal power station. The bi-directional flow-through bulb-type generating units used in the Jiangxia tidal power station are of two models and were manufactured by the Jinhua Water Turbine Factory of Zhejiang and the Fuchunjiang Hydraulic Machinery Factory. The bi-directional aspect was designed based upon the characteristics of China's tides. Power can be generated both when the tide water is entering and receding. In one day the tide ebbs and flows twice, therefore, power can be generated four times. Generating unit number 1 has been operating for 9 years, the others for 3 years and they have performed well thus far. Experiments in the prevention of corrosion of the generators by seawater and the attachment of marine life have been successful.

Along China's tortuous 18,000 kilometers of coastline there are innumerable large and small river mouths and harbors which contain abundant tidal power resources. Data indicates that China can develop tidal power stations with an installed capacity of 20 million kilowatts and an annual generation of approximately 58 billion kilowatt-hours, 95 percent of which would be distributed to coastal east China. [passage omitted]

### **Xinjiang Wind Power Facility Now Operational**

906B0025C Urumqi XINJIANG RIBAO in Chinese  
1 Oct 89 p 1

[Excerpts] On 28 September, the number 1 Dabancheng wind power facility, located in the Dabancheng valley wind region, joined the grid. Its total installed capacity is 2,105 kilowatts for a design annual generating capacity of 7 million kilowatt-hours. [passage omitted]

The work to design, build and install this wind power facility was begun in May 1988 by the Office of Wind Power Planning and Design of the Xinjiang Department of Water Conservancy. For a portion of the construction funding, grants from the government of Denmark were used and the entire project was completed according to our designs. Today, in the first stage of this facility's engineering, there are 13 150-kilowatt wind units installed and one each of 100 kilowatts and 55 kilowatts, amounting to a total installed capacity of 2,105 kilowatts. It is the largest wind power facility in China in regard to the number of installed units and total capacity. [passage omitted]

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